JANUARY, 1937

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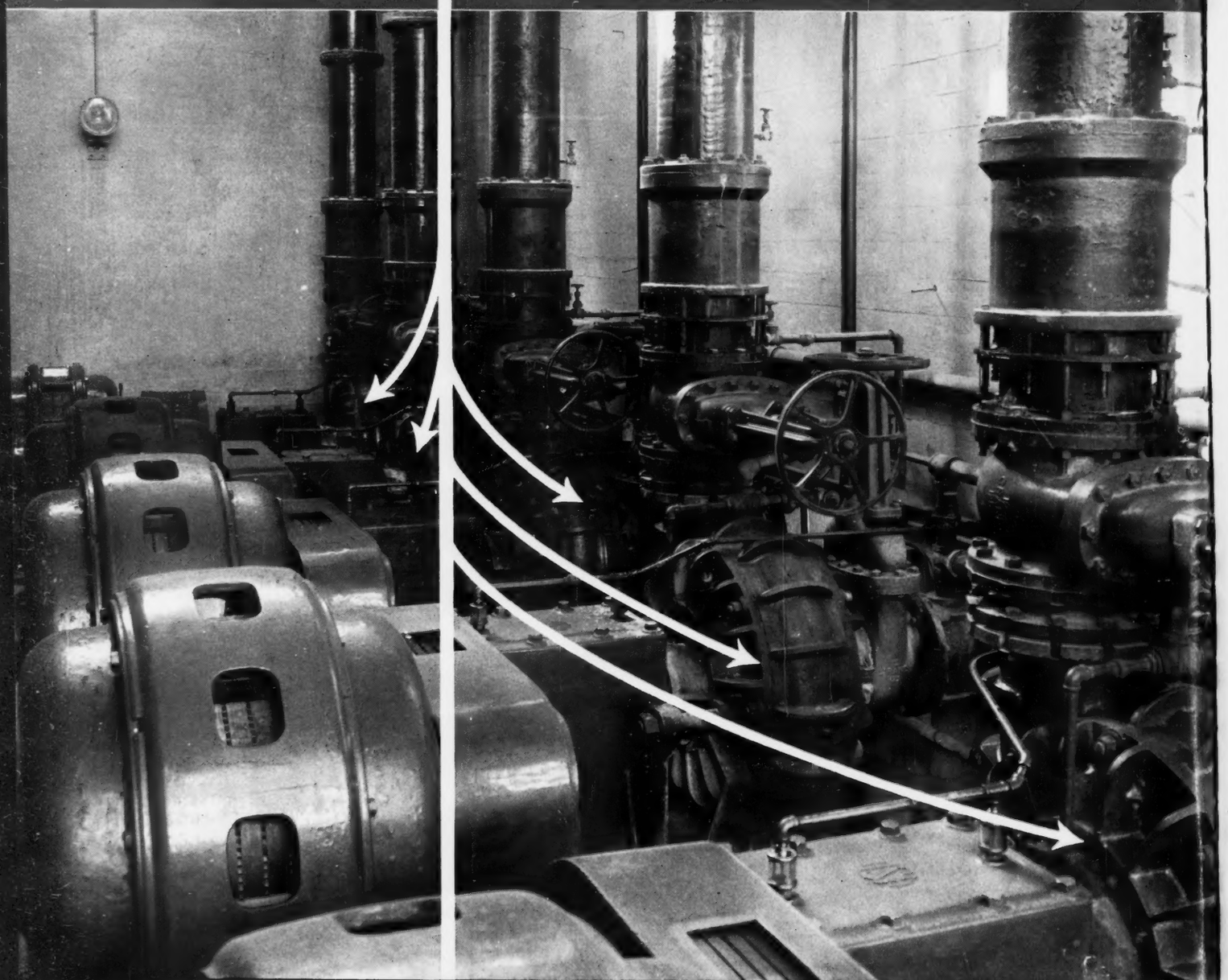

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The Annual Review and Outlook Number of the *E.&M.J.* will appear next month. The contents will include summaries of the respective situations in the major non-ferrous metals as well as thought-provoking articles on developments and trends in mining and non-ferrous technology.

✻

Waste Products often hide profits that are waiting to be made. This recalls the classic story of the pork packer and the hog. A few operators realize on everything in their ore. Most of them lack some needful market. Tri-State lead and zinc companies, luckily near communities that provide the outlets, turn their mine waste and mill tailings into money. W. F. Netzeband will give the details in an early article.

✻

Prince Rupert's Drop—that "glassy bubble that gives philosophers such trouble; whose one part cracked, the whole doth fly, and wits are cracked (or used to be) to find out why"—is suggestive at the moment of commodity and other market booms that have formed at one time or the other, only to collapse when something snapped the tension.

✻

Busy Mints. Halves, quarters, dimes, are "subsidiary silver," nickels and pennies are "minor coins," in language of the Treasury, which shipped $27,939,000 worth of the two groups during the first five months of the fiscal year 1936-37, more than the total for five fiscal years beginning with 1930. And the five months' shipment is two-thirds of the total for last fiscal year; $34,184,000. Largest increase was in nickels, meeting the demand for nickel games and goods venders and catching up with short nickel production during depression years, which reached a low ebb in 1932, with only $1,000 worth.

✻

Bingham District, Utah, is to have a mile-long million-dollar vehicular tunnel to connect two areas. (See the news). It will have two traffic lanes, also a path for walkers—a veritable subway. Which brings to mind certain city subways, any one of which required for its construction more drilling, blasting, and breaking than any mine on earth.

✻

The Spirit of 1937. In a small gold-mining district in Arizona, a group of miners got together and decided to present a courteous petition to the company stating their need for higher wages, as living costs were rising. No definite amount was asked, as the men had previously agreed to work at prevailing wages up to Jan. 1, 1937. The company raised wages on Dec. 15, therefore, Santa Claus's visit to the community was a merrier one.

✻

Transvaal gold production reached the record value of $33,890,000 last October. The output amounted to 977,425 oz., which is only 13,897 oz. short of the record of 991,-332 oz. in August, 1932. The October, 1936, output is the highest since the suspension of the gold standard.

✻

Bridges and Metals. Construction of the San Francisco-Oakland Bay bridge required 145,000 tons of structural steel, 30,300 tons of reinforcing steel, 19,115 tons of cable wire, 560,000 lb. of copper for light and power conduits, and 200,000 gal. of red lead and aluminum paint for protection of the structure.

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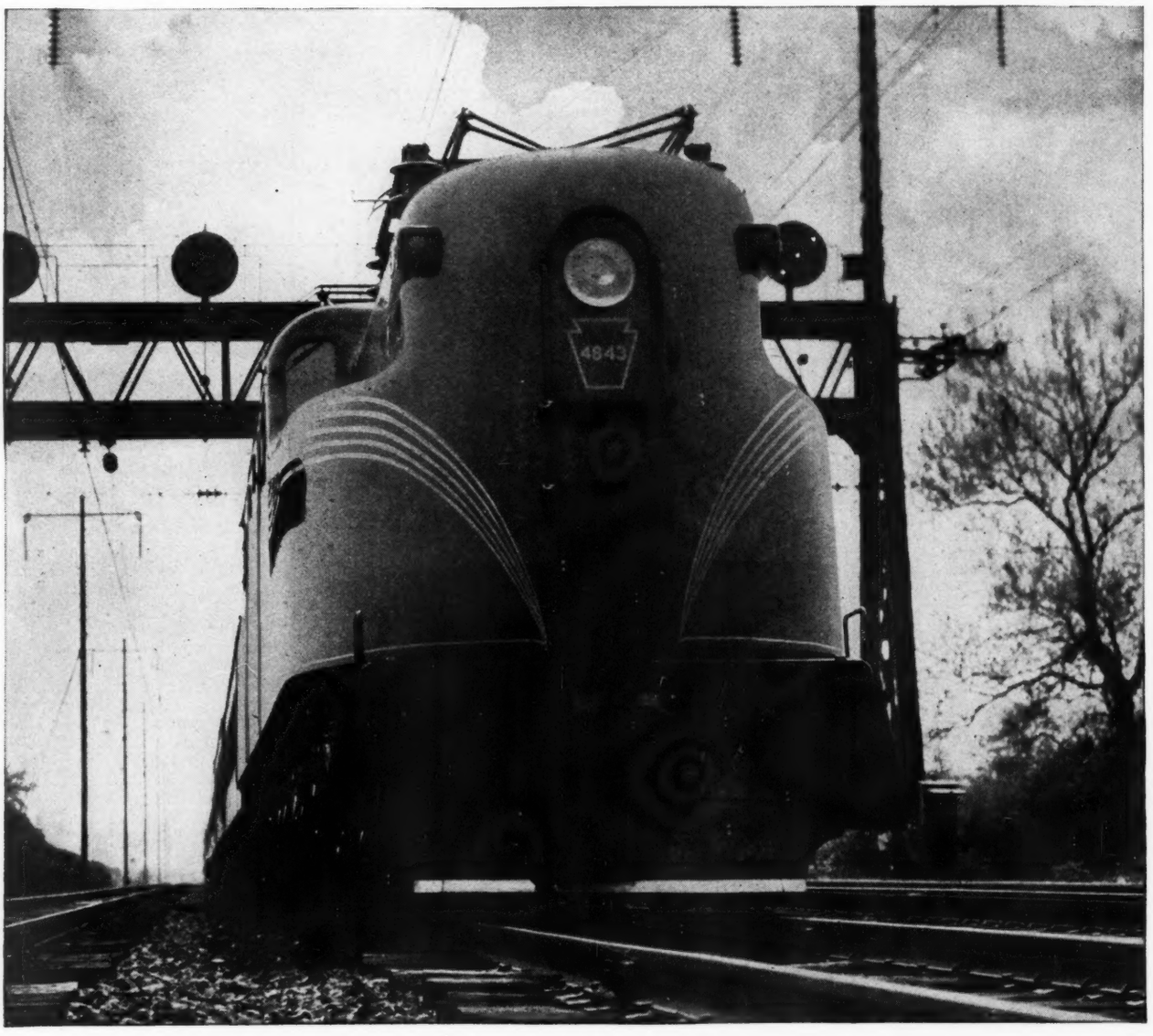

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Upward Swing of Metal Prices

RISING SHARPLY in the last month of the year, copper, lead, and zinc prices for 1936 made greater gains in thirty days than in the preceding eleven months. That the long-time trend in prices for all commodities would be upward, under present world-wide artificial stimulation of business activity, was well understood in metal circles. But both the rate of improvement in business and the urge by consumers to profit by extending their operations in raw materials have placed a severe strain on the markets. Much as United States producers welcome higher prices for non-ferrous metals, particularly after the late deep depression, the recent sharp upward trend in values has not been accepted without reservations.

Just what has occurred to the price level in copper, lead, and zinc during 1936, and in comparison with depression lows, is shown in the following compilation of *E.&M.J.* prices:

	Copper, Valley Basis	Lead, New York	Zinc, St. Louis
Dec. 31, 1936	12.000c.	6.000c.	5.450c.
Dec. 1, 1936	10.500c.	5.200c.	5.050c.
Jan. 2, 1936	9.250c.	4.500c.	4.850c.
Depression lows (1932-33)	5.000c.	2.650c.	2.275c.

The nervousness among producers, so evident as 1936 came to a close, was traceable to the feverish activity in copper and lead in London. As usual, the foreign speculators were heaped with blame for thoroughly disorganizing a well-planned market in metals. Then there was hedging abroad by armament makers, as well as continued recovery in world trade. Some observers even hinted that production controls might have had something to do with the desire to buy commodities for future profit. In any event, there were more buyers than sellers, and the natural lag between extracting metal from the ore and delivering the finished product to consumers accentuated the rise in prices.

To students of market behavior one thing stands out clearly: the necessity for maintaining ample reserves of commodities at important consuming centers if producers are really serious about establishing an orderly market and fair prices for raw materials. Large stocks are costly, but this added cost is part of the price that must be paid to discourage wild speculation.

Sir Auckland Geddes, chairman of Rhokana Corporation, Ltd., told stockholders last October that world stocks of refined copper had gradually fallen from 854,133 short tons in 1932 to 379,727 tons in September, 1936. The total tonnage now on hand appears to be ample, but the "confidential" statistics in the industry show that out of the quantity apparently available not much more than 200,000 tons is "industry," or producer-controlled, copper. Apparent consumption of copper for the world in the last quarter of 1936 was in excess of 160,000 tons a month. True, foreign copper producers have set up machinery for increasing output on short notice, which they have done. Those participating in production control are now operating at the rate of 105 per cent of the standards agreed upon, but it takes time to deliver copper from the source of production to where it is needed.

The buying of metals took on such volume during December that London prices for both copper and lead actually moved above domestic (United States) parity. To conserve domestic supplies of these metals for the domestic market, our own producers were forced to keep in step with London in marking up prices. Nervousness over the price situation is not likely to disappear until it can be demonstrated that the higher levels have not unduly stimulated production. The upward trend calls for the exercise of all the controls that producers can exert to prevent a disorderly metal market.

Let the Seller Beware

OFFICIAL WASHINGTON, according to our correspondent's report in this issue, professes not to understand the failure of copper producers to bid last month on Navy requirements for the red metal. By devious reasoning Washington would apparently have the public believe that collusion and retaliation on the part of the industry are at the bottom of the trouble. A better reason is at hand in the terms of the Walsh-Healy government contracts act, under which suppliers of commodities to Uncle Sam must agree to offer their wares. The copper industry is not alone in failing to respond to government proposals thus restricted.

Our readers will recall the origin of the Walsh-Healy Act. Following the demise of NRA, Congress enacted legislation imposing wage-and-hour restrictions on all who sought to do business with the Government in contracts amounting to $10,000 or more. Bidders had to comply with the Government's idea of maximum hours and prevailing wage rates determined by the Department of Labor. No stipulation, no contract. Thus some of the aims of NRA, which failed with respect to all industry, were to be imposed on that part which sought the favor of government contracts. In effect, the Administration hung out a sign reading "Let the Seller Beware."

Was it less than prudent, under the conditions, for industry to be reluctant to bid on government proposals? Nobody knew what trouble might be in the offing if he accepted the Government's restrictions. Prevailing wage rates were not announced in advance. Rather, they were to be determined arbitrarily as occasion arose. And once a contract was under scrutiny, no one could tell what technical flaws might be found or what requirements demanded. Under these circumstances it is folly to talk glibly about collusion, boycotting, and retaliation. Industry is simply unwilling to take the hurdle of the Walsh-Healy Act without knowing what's on the other side.

Checking Inflation

EVER SINCE business recovery took hold in earnest, warnings have been sounded that the rising wave of prosperity might break into uncontrolled and drastic inflation, with all its evil consequences. Two contributing factors caused some concern. One was the excess reserves in the hands of Federal Reserve member banks, and the other was the flow of gold into the Treasury from foreign countries and from current domestic production. Both were recognized as elements that were expanding the nation's credit base and setting the stage for inflation.

Last August the Federal Reserve put the brakes on credit expansion by increasing the reserve requirements of member banks by 50 per cent. But the steady inflow of gold partly offset the effect of this action. It became evident that further steps would have to be taken if the Federal Reserve's control was to be effective. So in December the Treasury announced its intention to "freeze" or "sterilize" new acquisitions of gold, financing the purchases by selling Treasury bills and holding the metal in an inactive account.

Thus the Government has twice within recent months exercised its power to control credit expansion and check inflation. Both steps having been taken before conditions made them urgently necessary, it will be possible to test the effectiveness of the experiments. Last year the Administration was intent on promoting recovery. Now the emphasis is being placed on control to avoid a runaway prosperity.

Profit Sharing for Miners

IN A TIME OF STRIFE between employer and employee it is reassuring to learn of the plan of the Idaho-Maryland management in California to share profits with its men. The policy should not only engender good feeling and a sense of common interest between capital and labor, but, equally important from an economic point of view, it will effect an equitable distribution of the profits of the enterprise. The point has been emphasized over and over during the past few years, not only by sound economists but also by smart industrialists, that inequitable distribution of profits is one of the factors that tends inevitably to upset economic balance and bring disaster. Mass buying power cannot be preserved if there is great disparity in the rewards enjoyed by the different groups that contribute to the success of a business venture.

During 1937, whenever Idaho-Maryland declares a dividend, the directors will set aside an amount equal to the dividend on 150,000 shares. This money will be placed in a fund to be distributed on December 15, 1937, among qualified employees as additional compensation for their services. Qualification will be determined on the basis of continuous employment, which should have a stabilizing influence on labor turnover. A man continuously employed by the corporation for six months, but less than one year, will receive four units; for one year, but less than two, five units; and for two years or more, six units. The unit will be an amount determined by dividing the entire fund by the aggregate number of units on the payroll.

In commending the general policy of an equitable distribution of profits, we may also point out that the Idaho-Maryland plan is only one of several that can be devised by intelligent management. Fairly administered, any such plan will give the worker confidence in the management and offer him a tangible incentive for loyal and efficient service.

HISTORICAL SUMMARY: ENGINEERING AND MINING JOURNAL was founded in 1866 as the *American Journal of Mining*, the title being changed in 1869. Publications with which *Engineering and Mining Journal* has been consolidated comprise: *Coal and Iron Record* (1875); *The Mining Review* (1877); *The Polytechnic Review* (1879); *Mining and Metallurgy* (1902); *The Mining Magazine* (1906); *Mining and Engineering World* (1917); *Mining and Scientific Press* (1922); *Engineering and Mining World* (1932). All rights to the foregoing titles of consolidated publications are reserved by the publisher. . . . THE FOLLOWING have served as editors in chief of *Engineering and Mining Journal* and its predecessor publications: G. F. Dawson (1866–67); R. W. Raymond (1867–74); R. W. Raymond and R. P. Rothwell (1874–89); R. P. Rothwell (1890–1901); D. T. Day (1901–02); T. A. Rickard (1903–05); W. R. Ingalls (1905–19); J. E. Spurr (1919–27); A. W. Allen (1927–33); H. C. Parmelee (1933—). . . . THE EDITORIAL STAFF of *Engineering and Mining Journal* comprises: H. C. Parmelee, editor; A. H. Hubbell, associate editor; H. C. Chellson, W. N. P. Reed, J. B. Huttl, assistant editors; H. H. Wanders, market editor; G. J. Young, consulting editor.

High Price Helps California Quicksilver

Local industry now producing about 1000 flasks per month

J. B. Huttl
Assistant Editor

QUICKSILVER mining, which has had a long and colorful history in California since the days of '49, is showing greatly increased activity. This is due not only to the gradually strengthening price as business is recovering from the depression, but also to special factors. The major sources of quicksilver are few, and these are confined to a few countries only. All industrially developed nations have need of it. Quicksilver is also an indispensable "war mineral." At the end of the World War, Italy seized the Austrian quicksilver mines at Idria (one of the world's large sources of quicksilver) and thus controls both it and the Italian quicksilver mines in Tuscany.

The largest source of quicksilver in the world is the Almaden mine, in Spain, which is at present in the hands of the Nationalists (rebels), who are recognized and backed by Italy. Hence any general war in Europe at this time would find the supply of quicksilver from three of the world's main sources in the hands of Italy and her allies and associates—an unprecedented situation. Should France and England, who have no large source of quicksilver of their own, be on the opposing side of any war, they would have to look to the United States—possessor of the only other large source of supply—for quicksilver, though smaller amounts could be furnished by Mexico, Russia, and perhaps China. The United States can furnish its own requirements of some 25,000 to 35,000 flasks per year at a price of $90 to $100 per flask, but any additional production could be produced only at a higher price for the metal.

Increased activity is particularly noticeable in the districts situated in Sonoma, Lake, Colusa, and Napa counties. In areas south of San Francisco Bay renewal of mining activities is indicated by development operations on many of the old properties, by the erection of several new treatment plants, and active search for new mines. Systematic treatment of old mine dumps has also played an important part in the gradually increasing production of recent years.

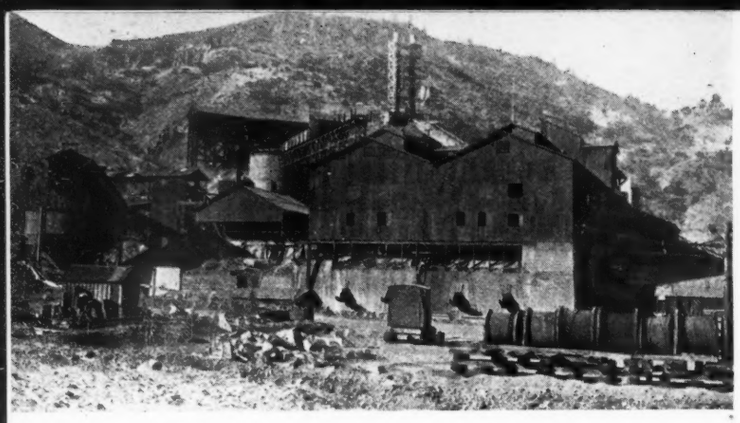
The principal California quicksilver producers are in the Coast Ranges, extending from Lake County in the north to Santa Barbara County in the south. Although quicksilver occurrences south of San Francisco Bay are widely scattered, the producing properties in the Sonoma-Lake-Colusa-Napa sector, in comparison, form a rather concentrated grouping. Scattered occurrences are found in Del Norte, Siskiyou, Trinity, Shasta, El Dorado, Kern, and San Bernardino counties, from which commercial quantities of quicksilver have been obtained from time to time.

As mentioned previously, the most important cinnabar deposits are in the Coast Range, in the Franciscan formation. This formation, Jurassic in age, consists mainly of sandstones and shales with small amounts of radiolarian cherts and limestone lenses, and some glaucophane schists. These Franciscan rocks were intruded by peridotites now changed to serpentine, and this entire complex of rocks is tremendously folded, faulted, and crushed. At a much later date, probably the Pleistocene, these rocks again were intruded, but this time by diabases and basalts and the ore deposition is associated with these intrusions, which generally came up through planes of weakness established by the peridotite intrusions, so that most of the quicksilver mines are on the sandstone-serpentine contacts. The orebodies are irregular but often of high grade, as they were formed when the ascending mineralizing solutions were trapped under fault gouges and deposited their loads of cinnabar in the fault breccias under them. This concept of the deposition of quicksilver orebodies in structural traps, first advanced by C. N. Schuette some six years ago, has proved to be a useful working theory in the search for new mines and new orebodies in old mines.

Outcrop ores are mined by either the glory-hole or open-pit method; open stopes, shrinkage stoping, top-slice, and square-setting are employed in underground mining. For processing the mined ore the larger operators use rotary and Herreshoff furnaces, and "D," Johnson-McKay, and Rossi retorts are in operation at properties where a moderate daily tonnage is treated. All furnaces and retorts use fuel oil, the cost ranging from 4c. to 10c. per gallon at the mine. Oil consumption is from 7 to 10 gal. per ton of ore treated. Average furnace feed assays from 5 to 10 lb. per ton. Electric power is obtained by some mines from power companies, but the more remote properties usually employ diesel plants for power generation.

Accurate and reliable cost data relative to mining and reduction of quicksilver ores in California are difficult to obtain except in respect to some of the larger operators. A close study made in the field recently, however, indicates that the average cost of quicksilver, not including such items as interest, amortization, and depreciation, is around $50 to $70 per flask, with total costs some $10 to $20 higher. Total production in California is close to 1,000 flasks per month. Most properties are accessible over good roads, and proximity to large centers of population assures an adequate supply of materials at all times.

Operators working low-grade surface ore (quicksilver content as low as 1.5 lb. per ton) usually screen the material drawn from the glory hole or pit as a rough means of concentration. Fair re-



REDUCTION PLANT
of New Idria Quicksilver Mining Company, principal producer of mercury in the Golden State

AT THE SULPHUR BANK MINE
near Lower Lake. The reduction plant, as here seen against the sky, is rather imposing

AT THE OCEANIC MINE
of the Anglo-American Mining Corporation's mine near Cambria, Calif., this plant serves for reducing the ore produced

THE KLAU MINE,
near Adelaida, has this ore-treatment plant

25-TON HERRESHOFF PLANT
at the Great Western mine of the Bradley Mining Company at Middletown

sults are obtained at plants treating ores containing relatively coarse cinnabar particles, one such operation obtaining a reduction of 5:1, effected by screening, with a recovery of 70 per cent of the values.

The newer reduction plants vary little in general design and in equipment used. Ore from the mine is reduced to about 1 in. by a jaw or gyratory crusher before entering the fine-ore bin at the furnace. Final treatment is received in a rotary or Herreshoff furnace equipped with a mechanical dust collector. It is interesting to note that nearly all plants now use the "Sirocco" dust collector, first introduced to the metallurgy of quicksilver by C. N. Schuette, consulting engineer, of San Francisco, Calif. The quicksilver fumes are moved from the furnace by a centrifugal fan and through the tile and iron-pipe condenser system to the flue leading to the smokestack. Soot thrown down in the condensers is placed on an inclined iron table top, mixed with lime, and then worked with a hoe as long as any metal will run out. The residue is either re-treated in a "D" retort or is recharged to the furnace with the ore feed.

Temperature readings are taken with electric pyrometers, the thermocouple generally being placed in the chamber above the feed end of the furnace. At this point temperatures from 450 to 600 deg. C. are maintained, depending on the character of the ore treated. No changes have been made in the silver room, though some operators filter quicksilver through glass wool. Shipments are made in standard 76-lb. flasks. Following is a brief description of active properties visited during a recent field trip.

Sonoma County — The Skaggs Springs mine, a relatively recent discovery situated at Skaggs Springs, is owned and operated by Leo Curtis. Development consists of a 45-deg. incline shaft about 180 ft. deep with levels at 45, 120, and 175 ft. Mined ore, assaying up to 60 lb. per ton, is treated in an oil-fired twelve-pipe Johnson-McKay retort capable of handling 3½ tons per day. Mining equipment consists of a small hoist and compressor, and from three to five men are employed at the property.

In the western end of what is known as the Mayacmas district, about 12 miles west of Cloverdale, Evan Bennett is operating the old Cloverdale mine under bond and lease. The mine is opened by several tunnels, and the surface ores treated at present are mined by glory-hole methods. Ore is hand-trammed to a small concentrating plant containing a revolving trommel covered with ½-in. screens, a shaker screen, and a concentrating table. Concentrates are trucked to the reduction plant, where they are treated in a "D" retort. The capacity of this retort is about 800 lb. a day, which is charged in two batches.

THE CLOVERDALE MINE

at Cloverdale, in Sonoma County, treats its quicksilver ore in this reduction plant

HEADFRAME

and Johnson - McKay retort furnace at the Skaggs Springs mine, at Skaggs Springs, California

Power for the mine and reduction plant is obtained from a small diesel plant. Production is about ten flasks per month, and seven men are employed.

About 2 miles distant, J. G. Cortelyou is working the Esperanza mine. The ore occurs partly in a contact ledge and partly as an impregnation in the sandstone. Both cinnabar and native quicksilver are present, with quartz as the principal gangue mineral, mixed with some serpentine. The mine is opened by three adits, one 600 ft. long, and daily production is 20 tons, which is treated in a small mill containing a jaw crusher, a set of 24-in. rolls, and a concentrating table. Mill heads average 3 lb. per ton. An oil-fired Johnson-McKay retort is available for reducing concentrates. Monthly production ranges from six to eight flasks, and about three men are employed.

The old Culver-Baer mine, 20 miles south of east from Cloverdale, is being reopened by the Vermillion Syndicate, headed by Donald Smith and R. A. Hanan, of San Francisco. H. W. Gould is consulting engineer for the company. Though the mine has not been in operation since the World War, it was for many years in the early '80s a profitable producer. Activities are now centered in rehabilitating the old tunnels and general development work. Installation of a 40-ton rotary furnace at a later date is contemplated. Ten men are employed under the direction of Carl Baumeister, superintendent.

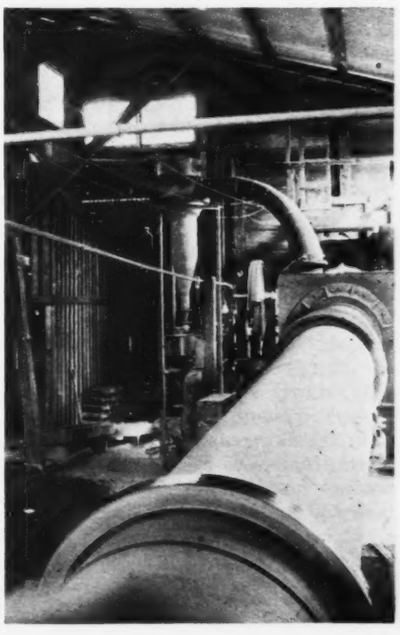
Lake County—The largest and oldest producer in Lake County is the Sulphur Bank mine, about 12 miles northwest of Lower Lake, operated by the Bradley Mining Company, Worthen Bradley, manager, which company is now the largest producer of quicksilver in the United States. This company now has two other quicksilver mines on production in California—namely, the Great Western and Mount Diablo, besides the quicksilver mines in Oregon and Nevada.

Worked as early as 1865 for sulphur, the Sulphur Bank mine, after having lain idle for five years, was reopened and developed for its quicksilver in 1873 and has produced almost continually ever since. The mine was originally opened by shallow shafts, but high rock temperatures and large quantities of hot water made underground mining impracticable. Today available ore is mined by open-pit methods.

The ore is found to a considerable extent mixed with sulphur in the lower zone of oxidation on decomposed basalt, shales, and sandstones. The cinnabar, associated chiefly with silica, is found as impregnations or irregular seams. Two pits are being exploited at present. Overburden as well as ore is removed by two Bucyrus-Erie diesel shovels equipped with 1¼-yd. dippers loading into 7-ton trucks. The waste-ore ratio is from 10 to 15:1. Ore delivered by the trucks is crushed to 2 in. by a jaw crusher before being elevated to a large storage bin by a bucket elevator. From here the material is transferred via a belt conveyor to a feed bin in the furnace building. The rotary furnace is fed by a Challenge feeder, and samples are taken at regular intervals by an automatic sampler. Quicksilver fumes, after leaving the dust collector above the feed end of the furnace, are blown successively through a steel-pipe condenser unit, a tile-pipe unit, spray tower, and several wooden tanks by a fan operating between the dust collector and the first condenser unit. A second fan of wood construction is installed behind the last condenser tank.

ROTARY FURNACE

for treating quicksilver ore and a Sirocco dust collector at the Mirabel mine, near Middletown



All dust except that from the dust collector is washed into large settling tanks. The underflow is pumped to a small agitator, whence it flows by gravity to a two-cell Kraut flotation machine. Concentrates are dried above a "D" retort, and tailings return to the agitator. Dried concentrates are treated in the "D" retort. Soot collected from the condenser pipes is dumped into a square, shallow tank fitted with a hot-water jacket and an agitator, which is set in motion after lime has been added to the charge. Quicksilver running out of the charge is taken to the silver room for bottling. About 50 tons of ore is treated a day at the reduction plant, and about 45 men are employed under the direction of A. F. Wolbert, superintendent.

The Great Western mine, operated by the company, is 4 miles southwest of Middletown. It has perhaps a longer record as a producer than any other mine in the district, and is credited with a total production of more than 100,000 flasks. The company acquired the property in April, 1936, and has done more than

1,000 ft. of development work since. The tunnel, known as No. 2 level, has been extended northwest, and several orebodies were opened by raising and crosscutting. Mined ore is being treated in a 25-ton Herreshoff furnace plant. C. N. Schuette is directing operations, which employ some fifteen men under Bert Mitchell as foreman.

About 4 miles south of Middletown is the Mirabel mine, owned and operated by the Mirabel Quicksilver Company, W. E. Best, president, and T. L. O'Connor, superintendent. The mine was opened in 1887 and has produced intermittently under different owners. Development work by the present owners has all been done on the part of the property known as the Great Eastern workings. This includes a two-compartment shaft 275 ft. deep, and an incline extending to 465 ft. Intermediate levels are maintained at 150, 275, 350, and 465 ft. Ore is mined by a modified shrinkage stoping method. Diamond drilling is in progress on the deepest level. Mine plant machinery consists of a 60-hp. hoist, a Sullivan compressor, and a drill sharpener. Shaft-sinking operations are carried on near the old Mirabel shaft.

The mine-run ore is crushed to ¾ in. in a gyratory crusher and then belt-conveyed to a storage bin at the reduction plant, which contains a rotary furnace, a dust collector, a fan, a ten-pipe condenser, and two wood tanks attached to the flue leading to the stack. Daily production of ore is about 25 tons. As in the operation of the Sulphur Bank and Great Western mines, power is obtained from the network of the P. G. & E. Company. A total of 26 men are employed.

Space limitations make it impossible to describe in detail the other mines more or less active in the district, which include the Big Injun, Big Chief, and Helen, all in the neighborhood of Middletown.

Colusa County—Save for the operations at the Manzanita mine and prospecting there is no other activity in the Wilbur Springs district than that of the Buckeye Syndicate, headed by L. R. Robbins and L. H. Baker, of Reno, Nev. The company has recently reopened the Wide Awake mine and at present is treating dump material in a 25-ton rotary furnace until the mine, which has been idle since 1900, has been rehabilitated.

Napa County—The principal producers in Napa County are situated in the Aetna Springs-Monticello-Pope Valley sector. Operations at the Oat Hill mine, near Aetna Springs, under lease and bond to the Gould and Hanan interests, of San Francisco, are at present centered in reworking old dumps, to be followed by underground development. About 65 tons of this material is trucked daily to the storage bin at the crushing plant, whence it is fed automatically to a rotary furnace. Other reduction-plant equipment includes a dust collector, a fan, a 12-pipe condenser, and three condenser tanks made from wood. Power is furnished by a diesel plant, and eight men are employed under the direction of R. F. Brown, superintendent.

Operations on a moderate scale are carried on at the neighboring Oat Hill and Switzer mines, worked by George H. Anderson and Frank Adams, respectively. Ore is reduced in Johnson-McKay retorts, and from two to four men are employed. At the Aetna mine a reduction plant similar to that at the Oat Hill mine is in operation, treating about 80 tons of ore and dump material a day. Other mines active in the area are the Knoxville, the La Joya, and the Ivanhoe.

Two Producers

San Luis Obispo County—The two largest producers in this county are the Oceanic mine of Anglo-American Mining Corporation, Ltd., near Cambria, and the Klau mine, operated under bond and lease by the Gould and Hanan interests, at Adelaida. The Oceanic mine is developed by a tunnel, known as the 400-level tunnel, and all production below this level is hoisted through an internal shaft extending below the 700 level. Mining operations are carried on in the glory hole, between the 300 and 400 levels, and on the 470, 500, 625, and 700 levels. Preparations are under way for development on the 200 level. The mining methods employed underground are top-slice caving and square-set timbering with waste fill. Ore is trammed by hand to the loading pockets in the shaft and to transfer chutes on levels above the main tunnel. At the portal of the tunnel the ore is crushed to 2 in. by two Blake jaw crushers and transported to the reduction plant via a Painter aërial tramway 2,600 ft. long. About 75 tons are delivered daily to the storage bin at the rotary furnace.

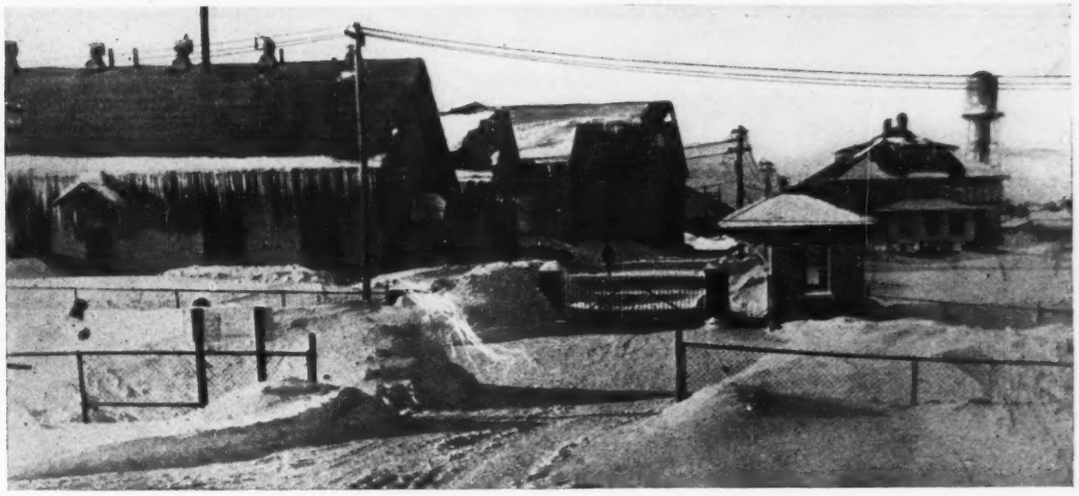
Treatment methods and equipment are similar to those described previously—namely, the quicksilver fumes from the furnace pass successively through a concrete dust chamber, a mechanical dust collecter, a fan, a double-deck, three-unit condenser consisting of 18-in. cast-iron pipes, and four redwood tanks before they enter two terra-cotta pipes leading to the stack. Condenser soot is treated with lime, the residue being re-treated in an oil-fired "D" retort. The ore treated assays from 4½ to 5 lb. per ton, and the monthly production of quicksilver is from 130 to 150 flasks. Electric power is obtained from the Midland Counties Public Service Corporation. Walter Lyman Brown is president of the company, and M. J. O'Boyle, superintendent, is in charge of the mine and plant. About 45 men are employed.

At the Klau mine ore is hoisted through an incline shaft sunk at an angle of 16 deg. and 24 deg. in ¾-ton cars. Present work is above the old workings, in the Underwood, Rossi, and Pierson stopes, but exploration at depth is contemplated and the shaft is gradually being deepened and is now 45 ft. below the water level. Ore is mined by open-stope methods, with an occasional stull used to hold loose ground. At the storage bin it is crushed to 2 in., which is followed by treatment in a rotary furnace, into which it is fed by a shaking feeder. Dust and condenser equipment includes a mechanical dust collector, a fan, a 16-pipe condenser, and two redwood tanks with Pachuca bottoms. Soot from the condenser pipes is hoed with lime, and the residue is returned to the furnace. About 35 tons of ore are treated per day, and the monthly production is from 75 to 80 flasks. Power is furnished by a small diesel plant. Bruce A. Gould is superintendent, and seventeen men are employed.

Other mines more or less active in the county are the Rinconada, the Warren Ranch, the Polar Star, the Bonanza, the Deer Trail, and La Libertad.

San Benito County—At Idria, the New Idria Quicksilver Mining Company, T. J. Hoover, president, and H. W. Gould, vice-president and general manager, is reopening the New Idria mine. Old mine workings are being cleaned out, and at the reduction plant one of the four rotary furnaces is being reconditioned, which will enable the company to treat up to 150 tons of ore per day. At present a washing and screening plant is treating about 200 tons of dump material a day. It is moved by a gasoline shovel loading into trucks operating between the pit and the storage bin at the reduction plant. From the bin the material is belt-conveyed to a revolving trommel, the fines going to a Dorr classifier and the oversize to waste. Classifier sands are treated in two Pan-American jigs, and the overflow is passed to settling tanks. Gordon I. Gould, superintendent, is in charge of operations.

Santa Clara County—Apart from leasing operations carried on at the New Almaden, Senator, and Guadalupe mines, all about 12 miles from San Jose, no major activity is in progress at present. At the New Almaden mine a small screening and washing plant containing a revolving trommel and a Pan-American jig has recently been installed by Paul Muench to work dump material, and a small mill is in operation on the Senator property. Rossi and Johnson-McKay retorts are used for treating screened ore and concentrates.



THE GATE at Teck-Hughes, at Kirkland Lake. Beyond the fence on the left are change house, machine shop, and mill, in the order named. At the right in the rear is the staff house

Teck-Hughes Mills 1000 Tons Per Day

The cyanide plant superintendent describes the work, emphasizing the many interesting mechanical details

Edwin H. Whitman

Mill Superintendent
Teck-Hughes Gold Mines, Ltd.
Kirkland Lake, Ont.

IN A PREVIOUS ARTICLE[1], published several years ago, Teck-Hughes metallurgy at Kirkland Lake was described at some length. However, attention in that article was directed to the metallurgical features of the cyanidation practice rather than to the numerous and interesting mechanical details of the process. These will therefore be emphasized in the following description, so that it will be essentially different.

Milling facilities at present comprise the "new" 1,000-ton plant[2], built in three sections, which is working on mine ore daily, most of this being hoisted up the South shaft, and the old mill, the operation of which is confined to regrinding and cyaniding 225 tons of impounded tailings daily during the summer months. This tailings plant is entirely separate from the 1,000-ton mill, save that the rich solution it produces is delivered to the larger mill for precipitation, barren solution being pumped to replace it. The tailings plant will not be described.

Adjunct to these are the Central and South crushing plants, respectively. Equipment of the former includes a 24x15-in. Superior jaw crusher, one Niagara screen, and a 6-in. Allis-Chalmers Superior McCully fine-reduction crusher, with the necessary conveyors. That of the latter plant consists of two 24x15-in. jaw crushers, one of these primary and one secondary; also a Niagara screen and a 4-ft. Symons Cone crusher.

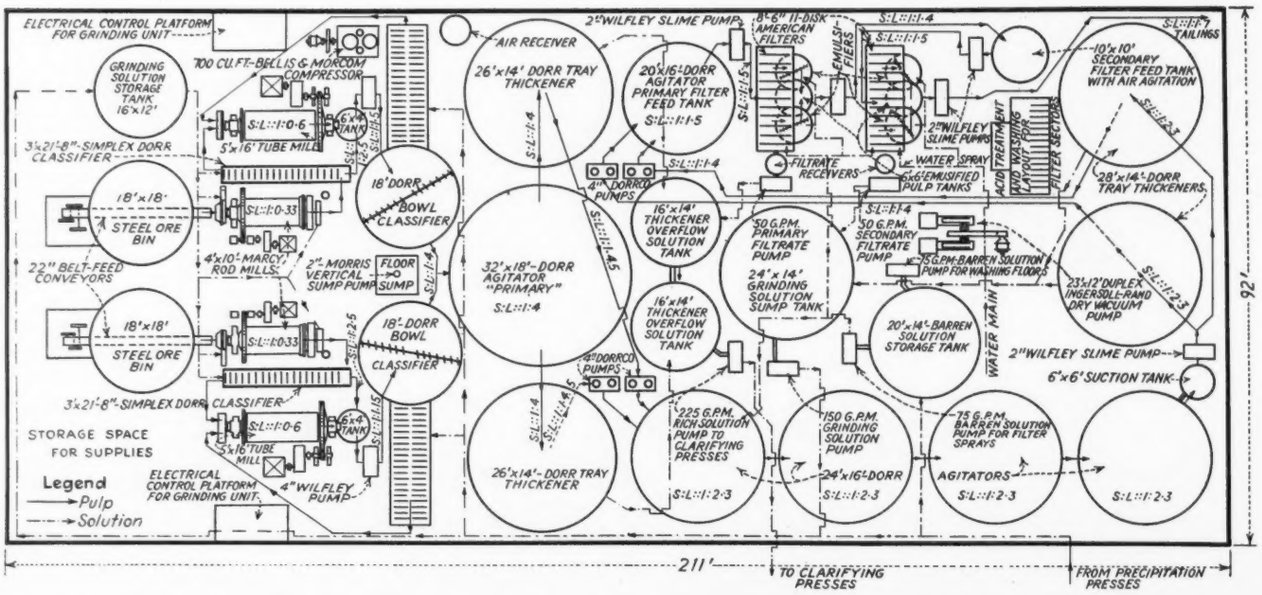
Grinding in the Central mill is done with six 4x10-ft. Marcy rod mills, six 5x16-ft. tube mills, six Simplex Dorr classifiers, six Dorr bowl classifiers, and six 4-in. Wilfley sand pumps. This equipment is divided among the three sections or units. The flowsheet of No. 3 unit is reproduced herewith. Grinding is followed by primary agitation and primary thickening, secondary agitation and secondary thickening, and double-stage filtration. The Merrill-Crowe vacuum system of precipitation is used. The various types of equipment will be described in detail.

Crushing Plant—At the South shaft the ore is hoisted in 5-ton skips and dumped into a 450-ton flat-bottom steel bin. This has a 36x36-in. opening in the bottom, through which the ore feeds onto a 42-in., 6-ply, 32-oz. duck ($\frac{1}{16}$-in. rubber back and $\frac{3}{16}$-in. rubber face) conveyor belt, driven in turn by a Link-Belt variable-speed reducer. This provides any speed required and is controlled by means of pushbuttons from several different points at the crushing plant. Great care must be taken when installing skirt boards, skirting rubber, or wear plates used with this belt, because it receives run-of-mine rock and is subject to much abuse. The belt now used is the third since 1930.

Ore is discharged from this belt onto a manganese-steel bar grizzly having a 4-in. opening, the oversize going to a 24x15-in. Superior jaw crusher. Crusher discharge and the fines from the grizzly are then delivered to a 24-in. conveyor belt, which discharges onto another bar grizzly having a 2-in. opening, the coarse rock

[1] Published in the *Canadian Mining Journal*, December, 1931.

[2] The first unit of this mill was finished in February, 1927; the second in August, 1928; and the third in March, 1931.



FLOWSHEET OF NO. 3 UNIT of the Teck-Hughes cyanide plant at Kirkland Lake. Three such units comprise the 1,000-ton mill, save for the crushing and refining sections. The latter operations are described in the accompanying text

going to a secondary crusher with the grizzly fines. Crusher discharge and grizzly fines go to a third conveyor.

The jaw crushers are driven through Tex-Rope drives by 50-hp. motors. The ropes on the primary crusher have been in service six years. Toggles are of a good grade of white iron and have chilled seats. Type IXL babbitt is used in all heavy crusher bearings and gives a life of 24 months on main eccentric bearings and pitmans. Campbell's brick grease is used throughout on jaw crushers. The lips supporting both the swing and the fixed jaw plates are kept built up with arc-welded hard-facing.

Both the swing and the fixed jaw plate for the secondary crusher are of a non-choke type. The wearing face across the center is 6 in. thick, with deeper pockets in the back. Otherwise they are the same as a standard plate. The reason for adopting such a plate was to raise the crushing point and to decrease the wear on the end of the plate. This has also increased the life of the lip on the swing jaw supporting the plate six weeks to six months.

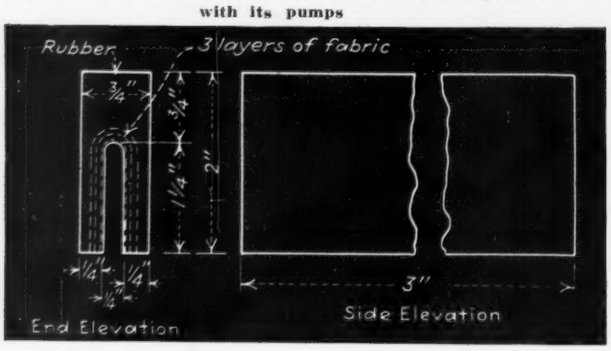
To compare costs, that of the standard swing-jaw plate is $60 and its average life 28,000 wet tons. The non-choke type costs $86 and has an average life of 105,000 tons. The fixed standard plate costs $68 and has a life of 30,000 tons, against the non-choke type at $96 with a life of 204,000 tons. These plates have been tried out in the primary crusher, but without success, due to the angle of nip being too great for large pieces of rock. All lime is added to the primary crushers.

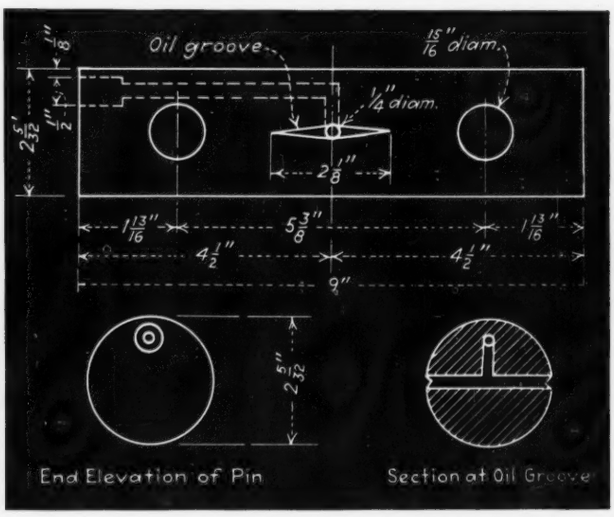
The ore is then passed onto a conveyor under a No. 4 lifting magnet made by Electric Controller & Manufacturing Company, of Cleveland, Ohio, which removes all tramp steel effectively. This conveyor discharges to a 3x6-ft. Niagara Counter Flow screen, with a $\frac{5}{8}$-in. square opening and a $\frac{5}{16}$-in. wire. The life of the wire cloth is 35,000 tons and that of the screen bearings 30 months, a light fluid grease, Marvelube No. 11, being used as lubricant. No lubricant is added if the dust seals show any sign of grease squeezing out. Bearings will run quite hot if too much lubricant is forced in under pressure.

Screen oversize goes to a 4-ft. Symons Cone crusher, set to $\frac{5}{8}$-in. discharge and driven by a 75-hp. motor, through a Tex-rope drive. The eccentric sleeves and all lower moving parts have been in service since 1930. This long life is due to the close checking of the lubrication. The sight oil-feed has a light installed behind it, which makes it visible from any part of the crushing plant. The oil used is Imperial No. 1 crankcase and it is filtered once every two weeks with a DeLaval sepa-

CONNECTING ROD PINS (at right), such as the pin illustrated, which are used on the bowl classifiers, have been drilled through longitudinally at the rake end with two outlets to enable the lubricant to reach both halves of the bearing

THE "DOCTOR BAR" (below) made of rubber, which is molded to slip on over the top edge of the scraper blades of the multiple-disk filters. Since this was adopted, one 6-ft. 5-disk filter has been shut down, together with its pumps





rator, this in turn being taken apart every two months and cleaned. A steam line has been installed along the feed oil pipe to make sure that the oil will not stop flowing during cold weather or on starting up after a shutdown. Oil consumption is one barrel per year.

We have found that it is more economical, and that the crusher delivers a more uniform product at the start, if the manganese-steel wearing parts are never both changed at the same time. We always use one that is partly worn when the change is made. The average life of the mantles is 53,000 tons and of the bowl liners 65,000 tons.

To stop the crusher back metal from squeezing out around the bottom edge of the mantle or of the bowl liner, when these are almost worn out, it is necessary to see that the first potful that is melted and poured in is of new material or metal that has not been melted before. Then one should fill up with old metal on top.

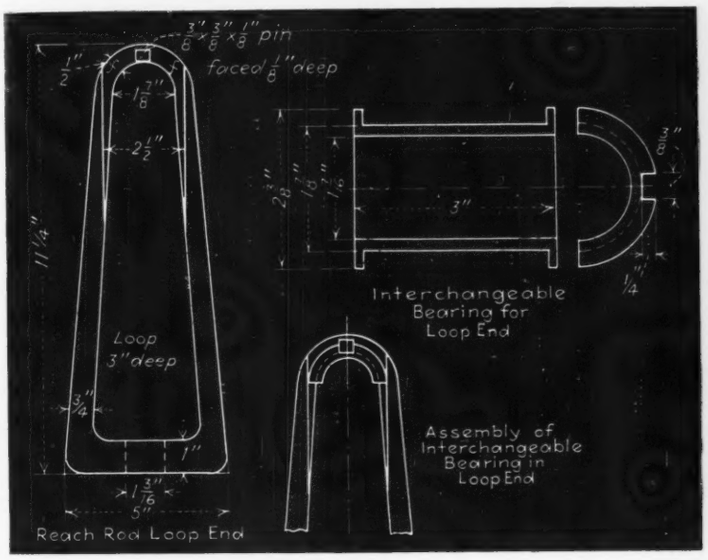
The Dust System—An exhaust fan, connected to the box which is built around the Symons crusher and the primary jaw crusher discharge, draws the dust-laden air through a vacuum-chamber collector, discharging the extremely fine dust outside and the coarse or heavier material onto a conveyor which carries it to the mill. Discharge of dust is so arranged that the crushed ore from the Symons crusher, together with the fines from the screen, is loaded on top of it, so that there is little chance for it to escape to the mill.

Conveying to Mill—Fines from the screen and the Symons discharge fall onto the same belt and are conveyed 700 ft. to the mill. There is one belt which is 475 ft. center to center, and another 225 ft. between centers. All conveyors are 24 in. wide, except one (42-in.) that feeds the primary crusher.

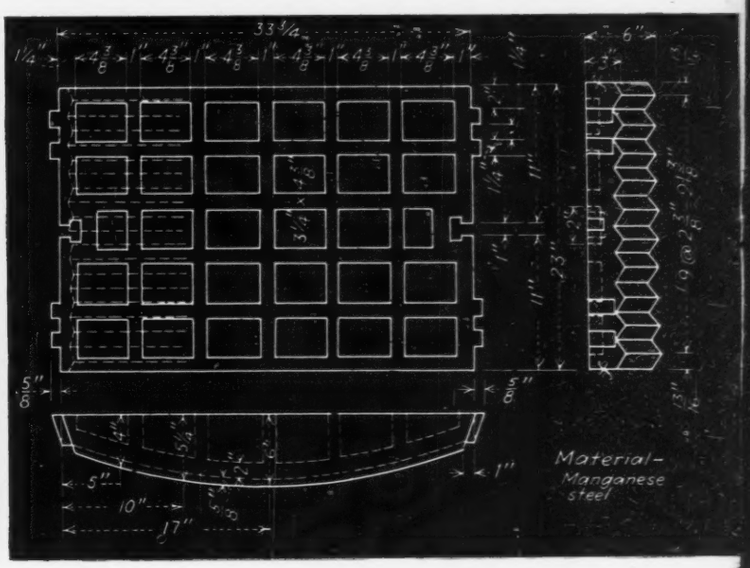
Link-Belt equipment is used throughout the conveying system. Return idlers have been covered with rubber sleeves purchased from the Dunlop Rubber Company. Use of these sleeves has done away with all wear on the face of the rollers and prevents fines from sticking to them, avoids shock to the idler bearings when fasteners are passing over them, and makes the belt easier to control during atmospheric changes.

Product of the Central crushing plant goes to the same bins as that of the South plant but by separate conveyors.

All ore is weighed between the crushing plant and the mill with a Merrick Weightometer.


faced 1/8" deep
Interchangeable Bearing for Loop End
Loop 3" deep
Assembly of Interchangeable Bearing in Loop End
Reach Rod Loop End

REACH-ROD LOOP END of the bowl classifier, as modified at the mill. The end has been machined out so that it will take an interchangeable bearing. This has increased the life of the loop end and pins



NON-CHOKE SWING JAW PLATE adopted on the 24x15 in. secondary crusher to raise the crushing point and decrease the wear on the end of the plate. The fixed jaw plate is also of a non-choke type

The capacity of the crushing plant is 90 tons per hour, and all crushing is done on two eight-hour shifts. Three men are employed per shift—a crusher man with a helper and a conveyor man, who picks off all scrap wood and switches the ore to the right bin.

Grinding—Inasmuch as the three units of the 1,000-ton mill are practically the same, all having the same milling rate, floor space, and other similarities, it will be necessary to describe only one in detail.

Ore is delivered from the crushing plant and stored in six 250-ton flat-bottom steel bins. The original bins have been raised 3 ft. on top, which gives greater storage capacity and makes it possible for the mine to avoid hoisting ore on Sunday. The ore is discharged from the 24x24-in. square opening in the bottom into a box, which is equipped with an adjustable gate. A 22-in. conveyor belt, driven from the tail pulley with a double-reduction drive, conveys it to a 4x10-ft. Marcy rod mill (six such mills are in use), where it drops direct from the conveyor head pulley into the drum scoop feeder, thus avoiding the use of any kind of chute. To allow this, the scoop box is cut away and the conveyor head pulley is set as close as possible to the scoop.

The feed-end trunnion liners are now purchased without a spiral inside, it having been found that the ore will feed in just as fast. The life of the trunnion liner has been increased, due to the greater uniformity of the wear. Manganese-steel step-type liners are used with the step running against the rod load, giving an average life of sixteen months. Liners are purchased from several different manufacturers and all give about the same length of life. All wood backing has been discarded behind the shell liners. Use of such backing had seemed only to increase the number of leaky bolts caused by the wood squeezing out and letting the bolts slacken. Heavy conveyor belting is used back of the discharge liners to cushion them and to decrease the shock produced at the end of the mill by the endwise thrusts of the rods. This also helps to prevent the end liners from hammering into the end of the mill.

The rod load is 10 tons and the rods are 3 in. in diameter when new. These mills are driven with 75-hp. motors through flexible couplings and Falk reduction gears at 25 r.p.m.

Pulp flows from each rod mill to a 21 ft. 8 in. by 3-ft. Dorr Simplex classifier, its dilution being held at 80 per cent moisture. No sands return from the classifier to the rod mill. The circuit is open, our final recovery proving it to be better to operate this way.

To avoid the necessity of replacing the Simplex classifier tanks because of rust and corrosion, false sides of ¼-in.

plate have been installed along both sides and end, with a 2-in. space between. This is filled with cement and a 3-to-1 sand mixture with 2 per cent Pudlo is added to make it waterproof. Thus the inside shell can rust and yet leave the classifier itself in good mechanical condition. This can be done without losing time and at little expense.

Sands from each Simplex classifier are sent to a tube mill, entering it by gravity. The classifier overflow enters a small tank that also receives the discharge from the tube mill. This tank has a punched plate screen on top to remove scrap wood from the circuit. A 4-in. Wilfley sand pump lifts the pulp from the tank up to a bowl classifier.

The tube mills are 5x16-ft. Allis-Chalmers units, each being driven by a 200-hp. motor. Gargoyle D.T.E. extra heavy oil is used in the reduction gears. Some of the bearings of these gears have been in service since 1928 and show little wear.

A ball load of 23 tons is used in the tube mill, half filling it. The size of ball is 1½ in. At present three of the mills are running on Dur-O-met and three on steel balls.

Pocket-type liners of white iron are used, purchased from the Cobalt Foundry at Cobalt, Ont. Their life is 25 months before the first replacements, or a total life of 33 months before changing completely. Pocket-type end liners are also being tried out, a trial set having been in use now for fifteen months, with considerable service left in them yet. One-inch common machine bolts are used for bolting liners to the shell. The scoop feeders are rubber-lined, the rubber lasting six years.

The Wilfley sand pumps are direct-connected and run at 900 r.p.m., their bearings giving a life of 24 months. A light oil is used for lubrication until the felts in the end caps and short cylinder heads become worn. They are then replaced with a fluid grease, such as Marvelube No. 11 or something similar. The average life of the pump runners, which are of white iron, is 94 days, that of the cases 114 days, and that of the rubber-faced follower plates 3 years.

Bowl Classifiers—These are classifiers with an 18-ft. bowl and a 6x30-ft. Type D Dorr rake. The drag arms make one revolution every 45 seconds with 17 rake strokes per minute. The tank slope is 2 in. per foot. These classifiers are operated at 80 per cent dilution.

Certain minor mechanical changes have been made on these classifiers, such as machining out the reach-rod loop ends so that they will take an interchangeable bearing. This increases the life of the loop ends and pins and also allows the lubricant to be forced around on the tight side of the pin. Connecting rod pins, at the rake end, have been drilled through longitudinally, with two outlets for lubricant to get at both halves of the bearing. As they were originally, only one half was lubricated.

An extension has been added to one drag arm on the bowl, with rubber attached to act as a scraper to keep wood and other refuse from accumulating.

All cam pins are welded in place before being put into service. Due to corrosion, rear apron plates commonly crack or break just where the rear hanger bearing goes through. These are replaced by cutting off the old apron at the solution level and bolting on a new half, which saves time, as the original apron is not otherwise disturbed.

The circulating load in the bowls is approximately 100 per cent. Sands return to the tube mill by gravity.

Overflow from the two bowl classifiers on each unit enters a 32x18-ft. Dorr agitator by gravity. The agitator speed is 3½ r.p.m. Extra air is introduced in the bottom of the tank at five different points, four of these being 3 ft. from the edge of the tank and the other in the center under the column. Piping for these air lines is continued up through the bottom of the tank and the "hardpan" (the coarse sand that has settled out) until it just clears the rakes. This seems to be an advantage after power interruptions, inasmuch as they always stay clear.

Some agitators handling heavier pulp in other parts of the circuit are equipped with an angle-iron extension on one distributing arm which supports a heavy chain which drags around and keeps any slime from building up on the side of the tank and thus cutting down capacity. Air columns in the center have six 2-in. holes burnt in them to expel air and to keep the spider and the shaft from building up.

Primary Thickeners—Pulp flows from the primary agitators to two 26x14-ft. Dorr balanced-type tray thickeners. To keep spiders and stay rods from building up with hard slime, all stay rods have been removed, the only support that the rakes now have being from spiders. A 2-in. angle iron is bolted onto the steel work of the tank, 6 in. from the shaft, and runs down parallel with the shaft, being shaped to clear the spider and the rake by 4 in., the end being bolted through the staves.

Bottom trays are treated in somewhat the same manner. As a safeguard against the outside angle iron on the rakes catching on rivet heads or the reinforcing in trays, rubber is bolted to the blades, and, being 1 in. wider than the angle iron, comes in contact with the metal first and does away with any dragging effect and strain.

About 15 per cent more pulp is added to the bottom tray than to the top, insuring a better discharge from the bottom. If the thickener is balanced with overflow rings alone, we have found that the top tray will discharge nicely, but the bottom tray will eventually slow up and stop discharging, which will necessitate its being washed out.

Practice at Teck-Hughes has always been to wash out and examine all thickeners every two years. We find this very satisfactory. Seldom does one have to be washed out between those periods. It has been necessary to renew some of the steel work on thickeners due to corrosion and rust. This can be done by supporting the steel with a heavy set of chain blocks. The thickeners are kept running, it being unnecessary to empty them.

Overflow from the primary thickeners is pumped to the central part of the mill for clarifying and precipitation. The underflow is pumped with a 4-in. Dorrco pump at 59 per cent moisture to four 24x16-ft. secondary Dorr agitators. These are in tandem, the speed being 5½ r.p.m. Two extra air lines are used for agitation plus the center column.

Secondary agitator systems are all interconnected and can be switched from one unit to the other during filter interruptions. The discharge from the last secondary agitator is pumped to two 28x14-ft. Dorr thickeners, equipped the same as the primary thickeners.

Overflow of the secondary thickeners goes to the grinding tanks. The underflow is pumped at 54 per cent moisture to a filter storage tank which is a standard Dorr agitator.

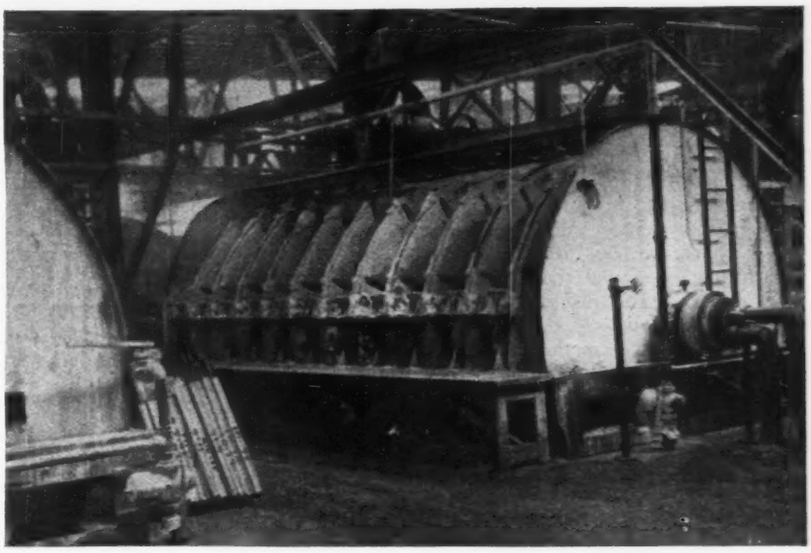
Filters—From the filter storage tank the pulp is pumped to an 8 ft. 6 in. diameter, 11-in.-disk American filter. This type of filter was designed to take the feed in the bottom of the hopper through the manifold, but this has been changed so that the pulp enters the top of the hopper, and the means of agitation, which is unnecessary, due to fine grinding, has been removed. Pulp in the filter storage tank is diluted to 60 per cent moisture. Addition of fresh barren solution here has been made possible only since the overflow from the filter hopper has been run back to the first secondary agitator. This is

Screen Analyses—Composite Sample From Six Single Grinding Units

Figures are in percentages

Mesh	Rod-Mill Discharge	Simplex Classifier Sands	Simplex Classifier Overflow	Tube-Mill Discharge	Bowl Classifier Sands	Bowl Classifier Overflow
+ 6	0.0	0.0	....	....	....	....
+ 14	3.0	5.3	....	....	....	....
+ 28	17.0	25.6	....	....	....	....
+ 35	12.4	18.8	....	....	....	....
+ 48	11.3	14.4	0.08	0.30	0.68	....
+ 65	5.3	9.4	0.01	0.20	1.97	....
+ 80	5.5	5.5	0.26	1.24	1.85	....
+ 100	5.3	6.1	1.75	2.80	6.84	....
+ 150	7.1	5.8	6.90	6.70	21.76	....
+ 200	5.2	2.3	6.21	8.48	25.41	0.34
− 200	27.9	6.8	84.79	80.28	41.25	....
+ 250	....	....	....	....	....	1.60
+ 325	....	....	....	....	....	6.22
− 325	....	....	....	....	....	91.84

WITHIN THE MILL
In the foreground is part of the primary thickener. Beyond this may be seen a bank of secondary agitators. The mill building requires no artificial heat in winter, thanks to good construction and the heat developed in grinding and by the motors



TWO-STAGE FILTRATION
used in the cyanide plant. Here is one of the two 8½-ft. 11-disk American filters employed. Its design has been modified so that the pulp enters the top of the hopper and the means of agitation has been removed

kept cut down to small bulk at all times. Overflow from the hoppers originally went back to the filter storage, which kept the pulp so dilute that it was inclined to hold the filters back. This change also permitted the removal of the spray pans from the filters. Spray pipes are 1 in. in diameter, and are bent to the same radius as the sectors and are suspended between them, spraying from two sides. This does the washing well, and the dissolved values are about 1c. The filters run at one revolution in five minutes. Ball thrust bearings, which take care of the worm thrust, are replaced with case-hardened steel thrust rings.

A number of different types of scraper blades have been tried out on filters, but they were not satisfactory until the rubber "doctor bar" was adopted. The first rubber-faced scraper blade to be used was a strip of launder lining 2 in. wide by ½ in. thick, bolted to the inside face of the blade. This was not satisfactory, as the rubber pulled away from the canvas back. The next used was of solid rubber and of the same size. This worked well in discharging the cake, but because of the way it had to be bolted to the scraper it was inclined to become wave-shaped, which would have increased the wear on the bags. Enough information was secured by the use of these rubber scrapers to adopt what the rubber companies now call the "doctor bar." This is a solid rubber strip ¾ in. thick and is molded to slip on over the top edge of the blade and go down 1¼ in. This is sufficient to allow bolting through the blade, which is done with six ¼x1¼ in. flat-head elevator bolts. The rubber will maintain a straight edge at all times. It is necessary to cut 1½ in. from the top edge of the scraper before installing the rubber. Due to the radius of the scraper with a 13/16-in. thickness of rubber on it, it is inclined so as to set the point of contact with the bag looking out instead of in. Cutting the edge of the blade makes this right.

Since adopting the rubber scraper, one 6-ft. five-disk American filter has been shut down, together with the slime and solution pumps. Changing of sectors on Sunday has been stopped and bag life has been increased from 60 days to 90.

Twenty-two sectors are removed each day from each filter for acid treatment and repairs. A 22-oz. I F P A filter twill is used in the filter bags.

Acid Treatment — Sectors removed from the filters are placed in a rack and washed well with water, then put in a bath of 2½ per cent acid for 30 minutes, and then set back in the rack and washed again, being turned up so that the drainage hole is on top and filled with water. After this water has drained out they are washed with the hose again. After inspection for small holes, they are ready to go back in the filter. It is important that all acid is thoroughly washed out.

All sector parts are purchased from the wood-working plant and assembled in the mill as wanted. A ⅝-in. square bar is installed in all drainage cap necks, when the sectors are being assembled, to support the center wood. This helps prevent a sector from coming loose when they are being assembled in the filter or moved around the mill. It is also important to see that the grooves in a sector have a free channel for escape of the solution. Sometimes, when a sector is assembled dry and then put into service, and it swells, the center section of the sector will choke off the drainage from the side sections. After the bags have been assembled with the sectors, they are painted on the outside under the sector guard, the bag clamp, and at the drainage cap.

Cake from the primary filters is discharged into the tank and emulsified

with barren solution. The paddles or stirring arms in these tanks are being equipped with rubber sleeves to give them greater life. Pulp from the emulsifiers is pumped to the secondary filter with a 2-in. Wilfley slime pump. These secondary filters are of the same size as the primary filters and are equipped in the same way. Vacuum is furnished by a 23x12-in. Ingersoll-Rand pump, which is sufficient for both the filters of one unit, an average vacuum of 25 in. being maintained.

The primary filtrate is pumped to storage tanks for precipitation and the secondary filtrate to grinding tanks. This solution is pumped with Rees-Turbo centrifugal pumps, manufactured by Babcock & Wilcox and Goldie McCulloch, Ltd.

Tailings Disposal—Tailings from all three secondary filters are being pumped to a central point in the mill, where they are picked up with a 4-in. Wilfley pump and pumped into a standpipe, entering it about 30 ft. above the floor. This standpipe is 3 ft. in diameter and 67 ft. high, and has 1¼ miles of 10-in. woodstave pipe for its discharge line. This line follows the contour of the ground, the highest point being 15 ft. above the base of the standpipe, and it crosses the lake at one point, a distance of 611 ft. Tees were installed at three of the highest points so that vents could be attached for air to escape, but after operating a short time we found these were not necessary. Drain valves were also installed at low places, with a quick-opening device, in case the line should have to be drained during cold weather.

This pipe line is not insulated in any way from cold, and during severe winter weather the temperature drops approximately 5 deg. F. between the mill and the end of the line. Pulp is pumped into the standpipe at 55 per cent moisture, then diluted in the 10-in. line to 70 per cent moisture. This is done by adding water to the 10-in. line 2 ft. from the base or the outlet of the standpipe. If enough water were added to the standpipe to give 70 per cent moisture at the end of the line, instead of adding it the way we do, it would require a much higher pressure to do the same work, due to the lighter pulp. The standpipe itself is not insulated from cold, there being 37 ft. exposed to the weather above the roof.

With the present tonnage of 1,000 tons from the new mill and 225 tons of re-treated tailings coming in from the old mill, the pulp level in the standpipe stands at 44 ft. above the base and has a low surging effect of 12 to 18 in.

Clarifying—Gold solution to the amount of 3,500 tons is pumped through three Merrill 42-in. square frame, central - sluicing clarifying presses, each one having 30 frames. No. 12 canvas is used and gives a life of six weeks. Nozzles in the sluicing bar have ⅛-in. openings and a flare of 3/64 in. to each hole. Presses are sluiced once every eight hours for a total of 5 min. with 60-lb. pressure, 2 min. with effluents closed, and 3 min. with them open. This is to make sure that the whole face of the canvas is properly sluiced. Water used for sluicing is taken from compressor cooling water and runs 98 deg. F.

Precipitation — Solution flows by gravity from the clarifiers to the storage tank and then into a steady-head tank, which is controlled by a butterfly valve. From there it is pulled into the Crowe system with two 6x4-in. Ingersoll-Rand vacuum pumps, the deaerated solution then being pumped to precipitation presses with two 400-g.p.m. Rees-Turbo centrifugal pumps.

Zinc dust is added to the suction of one of the pumps at the rate of ⅓ oz. per ton of solution. This connection is so arranged that it can be switched to either pump when repairs are being made. Zinc dust is added with the standard Merrill zinc feeder and emulsifying cone. Pump discharges are connected to one 5-in. line leading to the presses. Three 52-in. Merrill presses are used, two of which are always in service, each containing 35 frames. These are set up with No. 12 canvas cotton sheeting, and H. Reeve Angel No. 230 filter paper. The clean-up is made three times per month. Canvas gives a life of six months. The sheeting is burned in the refinery after every second run.

Principal Supplies Used for Year Ended Aug. 31, 1936:

	Pounds per ton
Lime	5.16
Cyanide	1.33
Rods	1.86
Balls	3.07

Zinc per ton of solution precipitated, 0.33 ounces.

Treatment cost per ton, $1.06. Recovery, 94.92%.

The Clean-Up—Precipitate is taken from the presses and lowered through a trap door in the press floor to the refinery. Two No. 3 Monarch (Rockwell) oil-fired furnaces are used. The proportions of the fluxing agents used are changed from time to time. At present 44 lb. of borax, 38 lb. of manganese dioxide, and 18 lb. of silica sand are being used to every 100 lb. of precipitate. This amount is thoroughly mixed in a mixing pan and added to one furnace. It requires one hour and thirty minutes to melt each charge, after which the metal is poured into buttons of bullion. The gold is then remelted into bars and is ready for shipment. Furnaces are lined with Carbofrax No. 3 cement, 1,200 lb. being required per furnace. Average life of the lining is 300 hours. Average fuel-oil consumption per hour per furnace is 12 to 15 gal.

Mill Building—The mill has an all-steel frame, is 211x276 ft. in dimensions, and is built on a flat site. Its walls are sheathed with 1-in. shiplap covered with Sisalkraft paper and Johns-Manville asbestos siding. The north wall is hollow tile plastered with cement. The roof is 40 ft. 8 in. above the foundation at its highest point and 29 ft. 3 in. at its lowest point. It is sheathed with 1-in. shiplap; on this are laid 1-in. strips to create an air space, then 1-in. shiplap again, and the last is covered with three-ply Toronto asphalt built-up roofing. The mill requires no heating except what is supplied from grinding and air compression. Solutions maintain a temperature of 80 deg. F. during the winter months.

The upper or working floor has about the same elevation as the top of the thickener and the agitator tanks. On it are the bowl classifiers, filters, sector-washing floors, precipitation control, Dorrco pumps, and electrical control boards. All centrifugal pumps are on the lower floor but can be controlled from the upper with valves or switches.

The lower floor is laid with smooth cement and slopes ¼ in. per foot, each unit floor draining to a 6-ft. square by 6 ft. deep sump, which is equipped with a 2-in. Morris vertical sump pump, which returns all floor washings or spills to the grinding circuit.

Good lighting is maintained throughout the mill from four skylights, each one being 8 ft. wide by 180 ft. long.

All line-shafting is 2 7/8-in. in diameter and is carried in SKF bearings and mounted on the lower chords of the steel roof trusses, 10 ft. from the working floor.

All supplies required on the upper floor, such as zinc dust and acid, are hoisted up with an Ingersoll-Rand hoist suspended from the mill roof. The 2-in. and 4-in. slime and sand pumps are all of Wilfley make and are driven by 5-hp. and 15-hp. motors respectively. Solution pumps are all made by Babcock & Wilcox and Goldie McCulloch, Ltd., and are direct-connected.

Operating costs for labor are quite low, one solution man and two helpers being required in the cyanide plant per eight-hour shift. One rod-mill man with two helpers is required in the grinding department per eight-hour shift. Additional men, required on day shift only, are: one oiler, one refinery man, three sector men who help change sectors and look after their repair, two laborers to clean up, and three repair men with helpers who cover the entire mill, including the crushing plants and the old mill during the summer months while on the re-treatment of tailings. No foremen or shift bosses are on the job from 5 p.m. to 7 a.m.

In concluding I would state that some of the changes described were made while H. N. Read was mill superintendent. 1934 Mr. Read was appointed general superintendent of Lamaque Gold Mines, Ltd., at Bourlamaque, Quebec.

THE JEWELL SHAFT, at the base of Sunshine Hill, has been sunk to a depth of 2,300 ft., but is equipped to reach 5,000 ft., if necessary. In the foreground are the shops and office

Sunshine Output Grows

Silver production doubled since 1934 . . . . Mill treating 600 tons per day . . . . Jewell Shaft is now down to 2,300 ft.

J. B. Huttl
Assistant Editor

EARLY in September, 1936, I had the privilege of visiting the operations of the Sunshine Mining Company on Big Creek, in Shoshone County, Idaho, which have attracted both national and international attention in recent years. The property lies in the southern silver belt of the Coeur d'Alene mining area, about 9 miles west of Wallace, and can be reached by leaving United States Highway 10 at a point 6 miles east of Kellogg and following the paved branch road to Big Creek, not quite 2 miles distant. Though J. T. Shimmin described in detail the Sunshine mine and metallurgical operations in *Engineering and Mining Journal*, Vol. 136, No. 6, June, 1935, a brief account of the progress and changes made since at the mine and mill may be of interest.

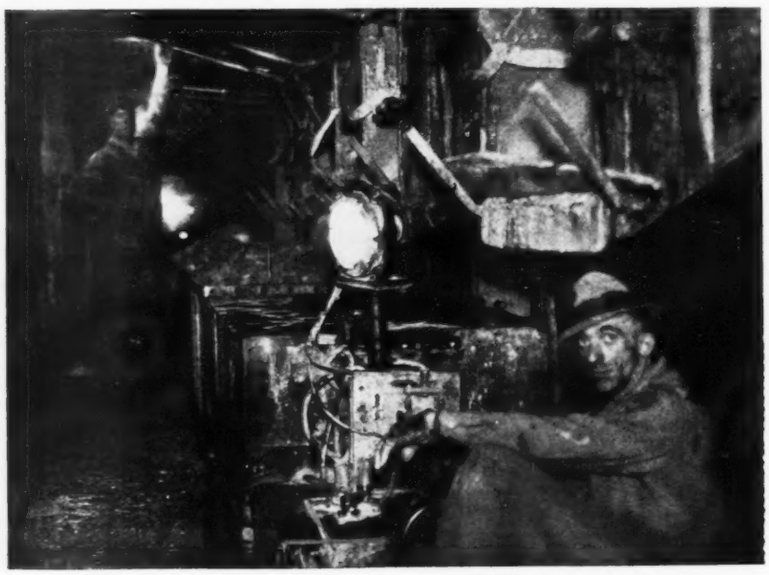
Silver has been mined spasmodically in and under Sunshine Hill for many years, but it was not until 1916, when the Sunshine holdings were consolidated and organized into the present company, that large-scale operations commenced. As mentioned previously, early work in the mine was confined to exploitation of small veins and bunches of ore in a wide mineralized zone above the adit level, the ore either being treated in a small gravity concentrator or shipped to the Bunker Hill smelter at Kellogg. The present company continued development at depth, and in 1934 stepped up production to 300 tons a day.

The mine is developed by an adit tunnel 1,700 ft. long, with a 65 deg. incline shaft extending from the tunnel level to the 1,900 level, and a vertical prospect shaft sunk from the 1,900 to the 2,300 level. Until recently, ore extraction was accomplished by the horizontal cut-and-fill stoping system. In an effort to reduce further dilution of the ore, experiments were conducted early this year with a modified timber-and-fill system, levels being spaced at 200-ft. intervals. The results obtained were satisfactory to the extent that the new method is being introduced in all sections of the mine. In territory now under development sublevels will be

THE NEW MILL has a capacity of 1,000 tons per day, but at present is operating at a rate of 600 tons. Tailings are retreated by duplicate flotation before going to waste

driven at 100 ft. to divide the 200-ft. main level intervals. Speaking broadly, the new stoping method differs but little from the conventional square-set and fill system.

Recognizing the inadequacy of the present mine openings in the event of increased production, and encouraged by favorable development underground, the management started work on a new four-compartment shaft early last year and drafted plans for a general modernization program. The new shaft, known as the Jewell shaft, has now reached a depth of 2,300 ft., and is being equipped to go to 5,000 ft. if conditions ultimately warrant. Between the 1,700- and 1,900-ft. levels the ground was excavated by raising from the latter level to connect with the shaft being sunk from the 1,700-ft. level. From the 1,900- to the 2,300-ft. level, however, the usual shaft-sinking procedure was followed. The shaft is already in use for handling timber and supplies. To provide access to the stations in the new shaft, crosscuts have been driven from the old shaft through the vein on the 1,700 and 1,900 levels. The connection on the 2,300 level has been completed.



LOADING ORE from chutes in the Sunshine mine. Production in the first nine months of 1936 totaled over 156,000 dry tons of ore, averaging 40.2 oz. of silver as milled

As will be seen in the accompanying photograph, the Jewell shaft is but a short distance from the mill. All timber sets in the shaft are made from Douglas fir. Wall plates and end plates are made from 12-in. material, and the dividers measure 10x12-in. in cross-section. Each compartment measures 4½x5½ ft. inside the timber, and all components of the shaft set are treated with zinc chloride, the consumption being about 1 lb. per cubic foot. The cross-section of the shaft is divided into two hoisting compartments, a service compartment to be equipped with hoisting facilities to lower men and materials, and a manway. Ore will be hoisted to the surface in 4½-ton aluminum or nickel alloy skips. The main loading station for materials, about 150 ft. below the collar of the shaft, is connected with the various supply buildings, grouped around the mouth of the tunnel, by an elaborate track system. When completed, the new shaft will be used for hoisting production exclusively from workings below the 1,700 level. Ore mined from the upper levels will be removed through the old shafts and adit. Electric locomotives and 2-ton steel cars are used on the haulage levels.

Improvements completed recently at the surface plant include a steel headframe over the Jewell shaft; erection of a general office; shops; timber framing shed; hoist house; extension to the mill building and installation of a 500-ton flotation unit; a large double-drum Nordberg hoist designed to operate to a depth of 5,000 ft.; and a high-pressure pumping plant for fire protection. In process of construction is a new crushing plant, which will contain a Traylor gyratory crusher, a vibrating screen, and a Symons cone crusher to reduce the screen oversize to minus ⅜ in. Crushed ore will be conveyed by a belt conveyor to the fine-ore bins.

Since completion of the new flotation unit daily production has been raised to about 600 tons. Total mill capacity exceeds 1,000 tons. Practically the entire output is treated in the new mill section, though the older unit is operated at set intervals during the week to prevent overload. The bulk of ore sent to the mill is mined on the lower levels from a strong vein varying from 1,500 to 1,600 ft. in length, which occurs in a fissure zone. The principal vein mineral is tetrahedrite, with small amounts of galena, pyrite, and arsenopyrite. Gangue is siderite and quartz.

Metallurgical operations differ but little from those practiced previous to the installation of the new mill unit, which contains a fine-ore bin; a 9x7-ft. Williamson ball mill with a 48-in. duplex Akins classifier; two Hydroseal 4-in. sand pumps; a 9x8-ft. conditioning tank; and the flotation equipment, consisting of a twelve-cell Denver Sub-A machine and Denver and pneumatic cells for cleaning tailings. Finished concentrates receive treatment in an Oliver filter before shipment.

Single-stage crushing in the 7-in. Traylor gyratory crusher preceded by a Tyler vibrating screen with ¾x1¼-in. openings will be discontinued upon completion of the new crushing plant at the Jewell shaft. Currently, the 1-in. material from the fine-ore bins is fed by Hardinge belt weighing feeders to the fine-grinding equipment, consisting in the old section of two 8-ft. by 48-in. Hardinge ball mills, each operating in closed circuit with a 36-in. duplex Akins classifier, and in the new section of a 9x7-ft. Williamson ball mill fed by a vibrating conveyor and operating in closed circuit with a 48-in. duplex Akins classifier.

The 6 per cent plus 65-mesh classifier overflow is elevated by sand pumps to the respective conditioning tanks before entering cell 2 of the twelve-cell Denver flotation machine in either mill section. Finished concentrates produced by cells 1 and 2 go direct to the Oliver filter to be dewatered. Concentrates from cells 3, 4, and 5 return to cell 1, those from 6, 7, and 8 go to cell 3, and concentrates from cells 9, 10, 11, and 12 to cell 6. Tailings from the twelve-cell Denver machines are re-treated by duplicate flotation units consisting of a four-cell Denver machine and an air cell, both operated in series, before going to waste.

All concentrates produced by the two four-cell Denver machines return to the classifier; those from the air cells go to the head of the ball mill. Sampling is done by automatic samplers, and mechanical reagent feeders are used exclusively in the flotation circuit. The filter cake shipped to the Bunker Hill smelter contains about 6 per cent moisture. Over-all recovery is about 98 per cent at present, and mill heads and tailings for the first nine months of 1936 averaged 40.2 oz. and 0.96 oz. silver respectively. Concentrates shipped to the smelter during the period just mentioned assayed 994 oz. silver. Ratio of concentration for this period was 28 to 1.

The company purchases power for mining and milling operations from the Washington Water Power Company. R. M. Hardy is president of the Sunshine Mining Company and R. D. Leisk is general manager.

Mine Pumps And Their Selection

II . . . For use where the installation is likely to be permanent

Lamar Weaver
Assistant Mine Superintendent
Tennessee Copper Company
Ducktown, Tenn.

PERMANENT PUMPS are those upon which the mine depends for the final disposal of its drainage water. They should be given careful consideration as to design, location, and installation, to secure the maximum economies. They may be classified as: (1), reciprocating pumps; (2), centrifugal pumps. The former may be classified as single, single-acting (rarely used, on account of the necessity for large air chambers to prevent water hammer); single, double-acting; duplex double-acting pumps; and multiple, these being made up of single- or double-acting pumps.

These pumps may be further classified as to type thus: Horizontal or vertical, with either plunger or piston and rings; double or single-acting, inside or outside packed. All of these, as said, are reciprocating pumps. Of them the vertical triplex and quintuplex power-driven pumps are most commonly selected for station use.

The piston-and-ring pump is designed for handling clean water at low heads. The piston type is widely used for gathering work. It has a loosely fitting piston, packed to fit the cylinder. This type is used up to 250-lb. pressure (Cameron). The plunger-type pump is designed for high lift. Its packing is outside and readily inspected, and it can be tightened while the pump is running. The plunger pump is large and heavy and naturally more expensive than the piston type, but is much preferred for dirty water, and is more commonly used for station pumps than any other type. For heads up to 1,000 lb. per square inch cast iron is used in building pump bodies, to 2,500 lb. cast steel, and above this pressure-forged steel.

Direct-acting steam ends are divided into simple, compound, and triple-expansion types. The simple type has a single cylinder, the compound a high-pressure cylinder and a low-pressure cylinder for expansion power, and the triple-expansion has a high-, a medium-, and a low-pressure cylinder. Extra cylinders are usually in tandem.

Centrifugal pumps are divided into two classes: the volute, and the turbine or diffusion ring pumps. In the former type, the casing is shaped in a smooth volute curve for converting velocity of the water leaving the impeller into pressure with a minimum amount of friction. This pump is especially adaptable for handling acid water and is efficient over a considerable head range.

The turbine is similar in construction with the exception of the casing, which is cylindrical with a diffusion ring around the impeller. Velocity is converted to pressure from the impeller through guide vanes of the diffusion ring into the outer casing. This type is in general use for high heads of non-corrosive water. With both volute and turbine types the required head is obtained by adding impellers in series upon a common shaft, the total pressure generated being the sum of the pressures of the individual stages. Figs. 8 and 9 illustrate the two methods of connecting for water passage, the principle used being the same.

In practice the number of impellers on a single shaft is limited by the vibration that will be set up in too long a shaft, the maximum being about six to eight stages. Additional stages are obtained with two pumps, as in Fig. 10, where two four-stage pumps are shown coupled to a single motor. Pumping heads rarely exceed 2,500 ft. for any centrifugal unit. The general trend is toward smaller units in stages of divided lift, relieving high pressures at the pump.

Volute pumps are popular for mine pumping, as they have fewer parts to fit and also embody the requirements desirable in centrifugal pump construction—namely, efficiency, ruggedness, reliability, low cost of operation and maintenance, and compactness. Some of the leading manufacturers of mine pumps recommend them exclusively.

No hard-and-fast rule can be made which will determine whether the plunger-type pump or the centrifugal pump should be used. Centrifugal pumps are to be preferred as requiring less floor space, lower initial cost, and being simpler to install, repair, and maintain, though with about 10 to 20 per cent less power efficiency. Speaking in general, the centrifugal pump gives best results when electric power is available at a rate of 0.8c. or less per kilowatt-hour. Under some conditions, however, where very acid and dirty water has to be handled, reciprocating pumps are recommended, especially where small capacity is required and the head is high. Where the water contains much grit or abrasives, a plunger pump will have a longer useful life than the centrifugal. The question of cost, involving the initial equipment, operating labor, upkeep, efficiency as it affects power bills, and the interest, may be the criterion.

Graphs giving the cost of both centrifugal and reciprocating pumps are shown in Figs. 11 to 15 inclusive. The prices used are based on standard equipment for handling neutral, relatively clear water. Prices (1936) increase for bronze and stainless steels.

The characteristics of the two types of pumps overlap so that it is possible to use either of them. This has been proved in mines in both the United States and Canada where operators have comparative data. A computation of the data obtained from inquiries directed to these companies indicates a preference for centrifugal pumps.

Much work has been done to improve the life of the wearing parts. Due to excessive wear of such parts, the plunger pumps have shown a saving in repair cost of from $1 to $5 per million gallons. Analysis of a satisfactory pumping cost for a 1,400- to a 1,500-ft. lift shows a repair cost of $3 to $6 per million gallons lifted, with a total operating cost of $90 to $110 per million gallons pumped.

Selection of the unit to be installed

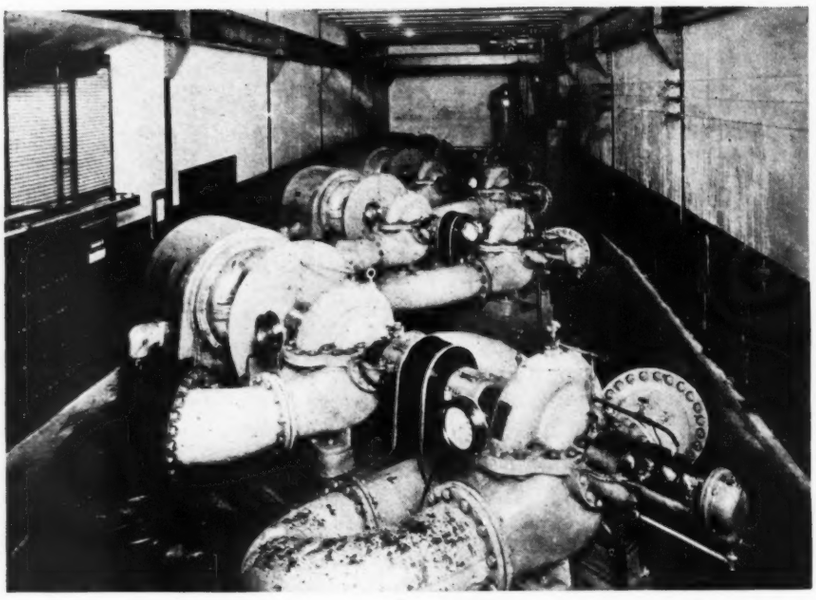


Fig. 8—THESE PUMPS, each of them a Hazleton two-stage, double-suction volute unit, together with the sectional view of the pump shown in Fig. 9, illustrate two methods of connecting for water passage, the principle being the same

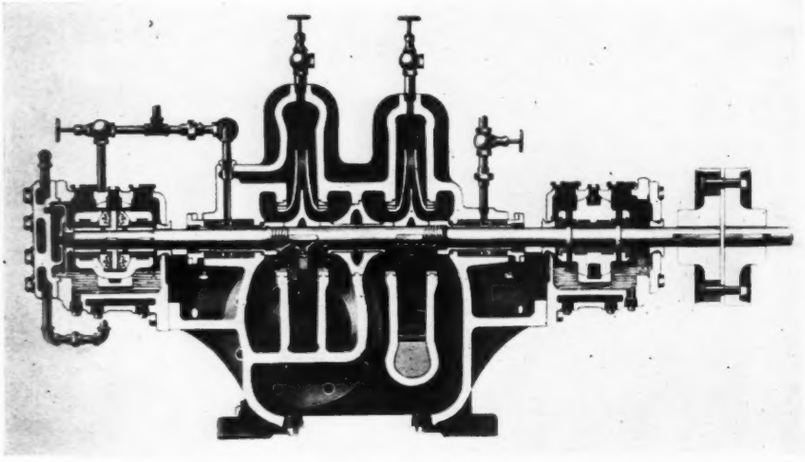


Fig. 9—WITH BOTH VOLUTE AND TURBINE PUMP the required head is obtained by adding impellers in series upon a common shaft. This two-stage double-suction volute Cameron can be had in capacities ranging from 100 to 2,800 g.p.m. and for heads of 300 to 600 ft.

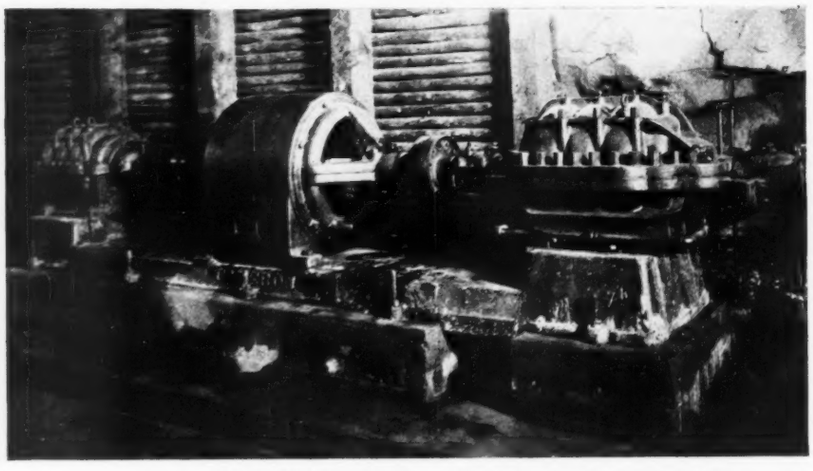


Fig. 10—AN EIGHT-STAGE PUMP produced by coupling two 6-in. four-stage Type MT Cameron pumps to a single motor. Capacity is 800 g.p.m. at a total head of 1,250 ft. This is a solid-bronze unit

should be based on purchase cost, installation, estimate of maintenance, life of pump, and cost of power. Assume, as an average, the following conditions: A mine; a 1,000-ft. lift; 420,000 gal. to be handled per day; some settlings but no acid; a power cost of $0.0085 per kilowatt-hour; and an apparent station life of ten years.

$$\frac{1{,}000 \times 420{,}000 \times 365 \times 8.35}{2{,}654{,}200}$$

equals 482,275 kw.-hr. per year
$0.0085 × 482,275 kw.-hr. equals $4,099.34 power cost per year at 100 per cent efficiency.

Suppose we select for this case pumps of both the plunger and the centrifugal type for one shaft operation, to equalize operating labor. These pumps are: One 1,000-g.p.m. centrifugal pump for 1,000-ft. head at 70 per cent efficiency. Two 500-g.p.m. triplex pumps at 85 per cent efficiency.

Respective volumes to be excavated for the stations are compared and the cost is included as part of the original investment. Thus: Dimensions of the centrifugal pumps are 2 ft. 7½ in. by 3 ft. 2¼ in. by 9 ft. 2¼ in. The rock opening required is 10 by 10 ft. by 9 ft. high, equaling 900 cu.ft.

Dimensions of the triplex pumps are 7 ft. 0 in. by 14 ft. 2 in. by 11 ft. 1 in. The rock opening required must be sufficient to include a 4-ft. walkway between the pumps, and is 14 ft. wide by 32 ft. long by 16 ft. high and equals 7,168 cu.ft.

As shown in Table III, the yearly difference favors the centrifugal pump.

With a change in the quantity of water to 42,000 gal. per day (1/10 of No. 1) the following pumps were selected:

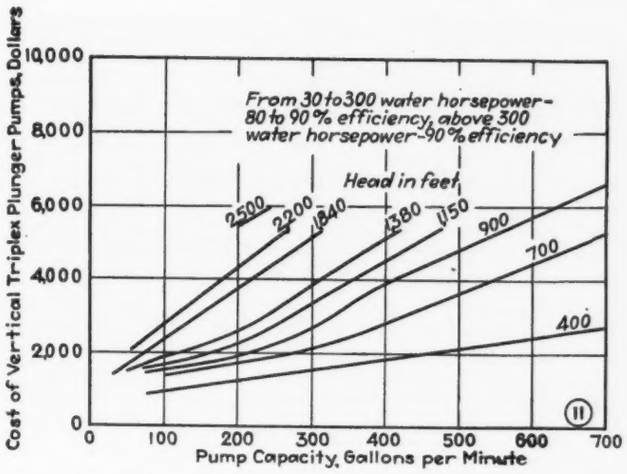
One 100 to 125-g.p.m. centrifugal pump for 1,000-ft. head, at about 40 per cent efficiency. One 100-g.p.m. triplex plunger pump for 1,000-ft. head, with 80 per cent efficiency.

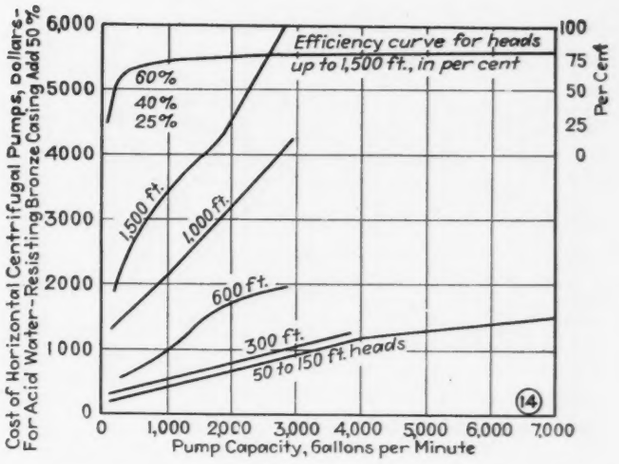
Size of centrifugal pump is 2 ft. 6 in. wide by 6 ft. 4 in. long by 2 ft. 1¾ in. high. Rock opening used is 8x6.5x8 ft. in dimensions, equaling 416 cu.ft. at $0.20, or $83.20. Plunger dimensions are: 4 ft. 2 in. wide by 8 ft. 4½ in. long by 7 ft. 2½ in. high. Rock opening used is 9x8.5x12 ft. in dimensions, equaling 918 cu.ft. at $0.20, or $183.60. As shown in Table IV, the yearly difference favors the triplex.

Water horsepower is the measure of work necessary to move the water from storage through pipes to the end of discharge. The required horsepower can be computed.

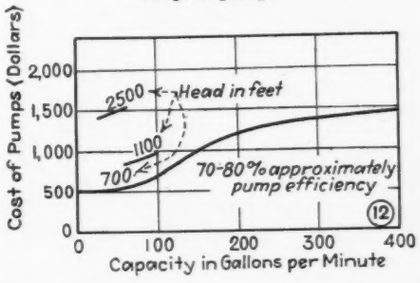
$$\text{Water horsepower} = \frac{HDW}{33{,}000} = \frac{HD}{3{,}592.1}$$

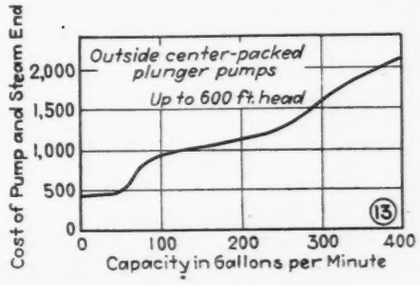
where $W = 8.35$
H = total head in feet (total dynamic head).
D = discharge in gallons per minute (g.p.m.).
W = weight of water in pounds per gallon (8.35).

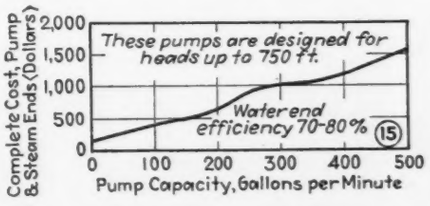




Figs. 11-15—COST CHARTS for reciprocating and centrifugal pumps. Fig. 11, Triplex pump. Fig. 12, Horizontal duplex power pump. Fig. 13, Horizontal steam or air duplex pump. Fig. 14, Volute-type centrifugal pump. Fig. 15, Cameron simplex pump






Complete Cost, Pump & Steam Ends (Dollars)
These pumps are designed for heads up to 750 ft.
Water end efficiency 70-80%
15
Pump Capacity, Gallons per Minute

To convert water horsepower to drive power, the water horsepower should be divided by the combined efficiency of the pump to be used and the transmission unit.

$$\text{Over-all efficiency} = \frac{\text{Water horsepower}}{\text{Horsepower required to drive pump}}$$

To get kilowatt-hour consumption over any period of time the total foot-pounds of water pumped should be divided by (2,654,200 ÷ efficiency).

Each pump unit should be provided with some means for measuring results. Thorough tests should be made periodically to determine any lag in efficiency or capacity, whereby plans for repairs can be made. Speed, discharge pressure at the pump, suction head, water discharge, and power input are obtained for this test. The usual instruments used at the pump are: pressure and vacuum gages, an ammeter (the operator's telltale), and the kilowatt-hour demand meter. The discharge water is measured by actual displacement and a stop watch, a weir, or commercial flow meters.

In asking for quotations or proposals from manufacturers the following general information should be given: Number required; capacity in gallons per minute; vertical suction lift in feet; horizontal length of suction pipe; elevation of discharge point above center line of pump, in feet; diameter of discharge pipe in inches, if the pipe is in place; length of discharge pipe in feet; total head on pump, including friction of discharge pipe. If an electric motor is wanted, one should state whether it is to be a.c. or d.c. and give the voltage; if a.c. is wanted, the cycle and phase should be stated also; if motor is furnished by the purchaser, the full name plate reading should be given. One should also state the character of water, whether fresh, acidulous, or gritty, and when possible give its analysis.

Where metals and alloys with acid-resisting qualities are wanted, the following may serve as a guide: Highly resistant: high-chrome steel and iron, high-silicon iron (silicon 14 per cent or over), lead-base alloys. Less highly resistant but used to a great extent: lead bronzes, bronze (not containing zinc), high-nickel copper alloys. Metals not suitable: gray iron, malleable iron, cast steel, brass or bronze containing zinc; also german silver, any zinc combination, and carbon and alloy steels other than high-chrome steel.

Automatic features are being perfected to such an extent that numerous important mine pumping stations are in operation which are not attended save by an inspector or an authorized person once or twice during a day. The added protection afforded the units, with the saving in attendance labor, will usually amply justify the extra cost of the automatic features.

Self-priming electric field pumps are often started and stopped by a float switch, a storage sump being usually provided for the suction pipe so as to give some leeway in the float action. The water is controlled at predetermined levels by float switch contacts.

Reciprocating pumps, whether motor-driven or steam-driven, in permanent pump stations will usually require attendance while in operation because of the number of parts susceptible of derangement or the manual processes involved in starting or stoping. Permanent pumps of the centrifugal type may require constant attendance when they are so isolated that too much time is required to reach them in the event of trouble. An exception could be made here when ample storage is available. Constant attendance may be necessary also when the pump station is so large that the time of one man is required for maintenance and cleaning.

Protective devices are available for automatically stopping a pump when unusual operating conditions arise. They perform the following functions: They start the pump at high water level and stop it at low level. They go through the priming process in starting. They protect the pump while in operation against damage due to air leaks, loss of water, blocked intake pipe, overheated bearings, and broken discharge pipe and lock-out features in case the pump cannot be primed. The lock-out feature includes alarm signals.

A dependable priming method is a necessity in pump operation. Those methods used for manual and automatic control are for description divided into two classes, in the order of degree of usage in mines: (1), where the water is below the pump (suction lift); (2), where the water is above the pump (suction head).

Priming of a pump by use of a foot valve and strainer is illustrated in Fig.

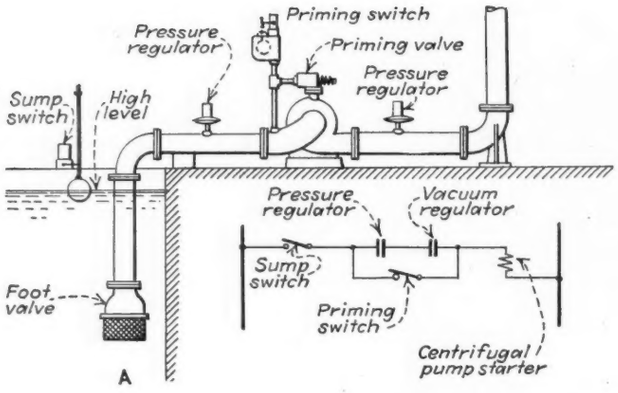
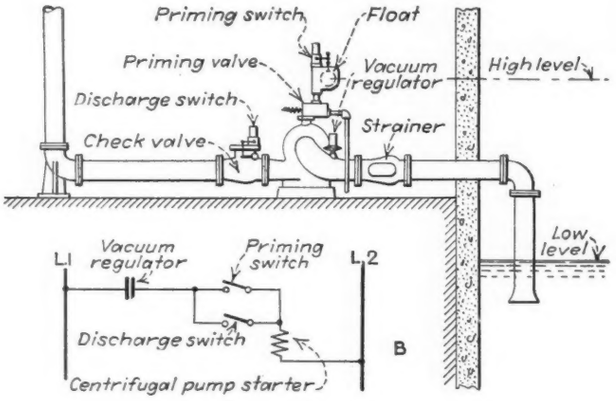


Fig. 16A—PRIMING is accomplished here automatically by means of a foot valve and strainer and a suction lift. A pump so primed must usually be protected against failure of the foot valve. Fig. 16B—An automatically controlled pump with head on suction



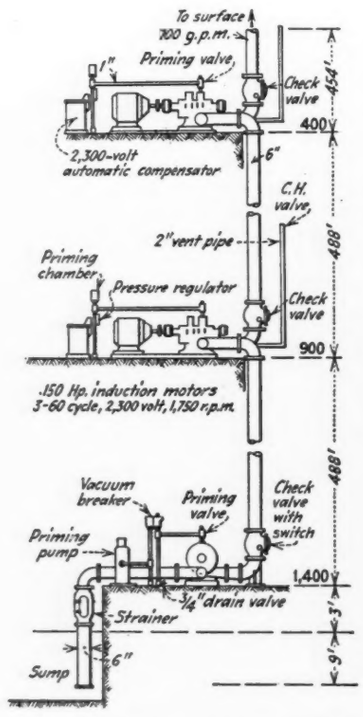


Fig. 19—BURRA BURRA SHAFT pumping installation of Tennessee Copper Company. This sketch (repeated from E. & M. J., June 12, 1931) shows automatically controlled pumps in series lift

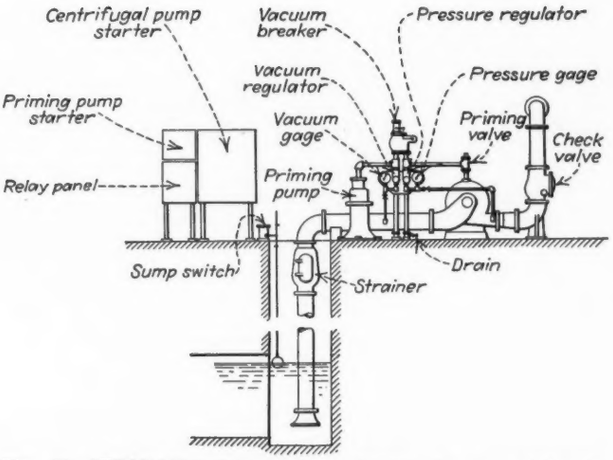


Fig. 17—AUTOMATIC CONTROL equipment for a centrifugal pump with suction lift. In this case priming is effected by exhausting the air from the pump casing and suction is accomplished by use of a motor-driven vacuum pump

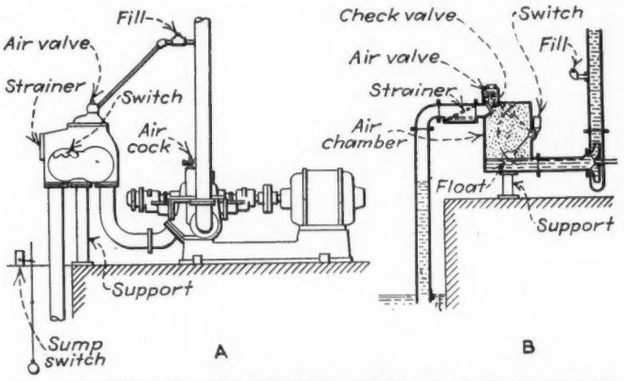
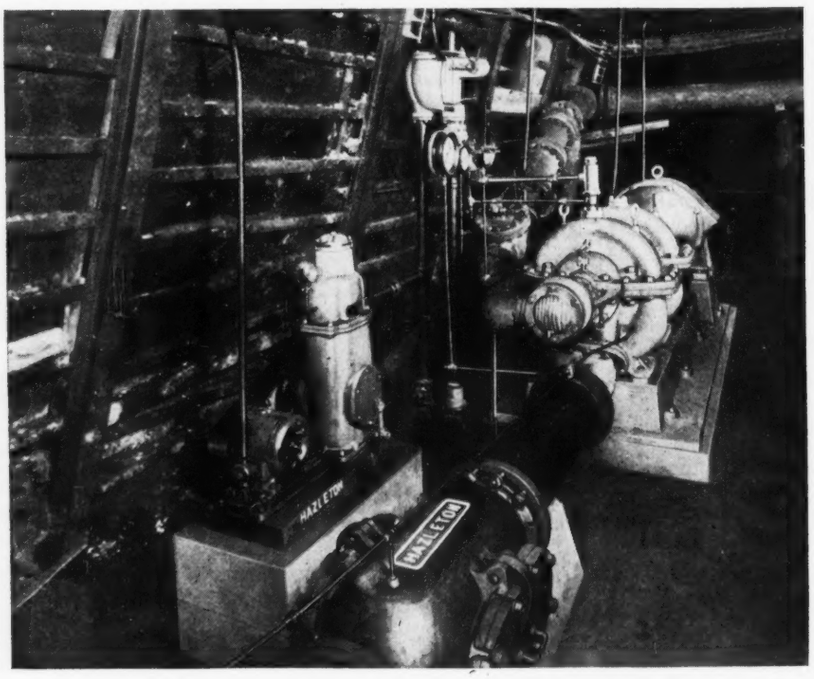


Fig. 18—SUCTION LINE PRIMER (Hazleton), made by Barrett Haentjens Company. This combines a strainer, a check valve and an air pump in a single casting

Fig. 18A—FOUR-STAGE CENTRIFUGAL PUMP, single lift, equipped with Hazleton accessories and automatic control equipment. This unit delivers 1,500 g.p.m. against 430 ft. total head and is driven by a 250-hp. motor



16, A and B. It is usually necessary to protect a pump that is primed in this way against failure of the foot valve. If the valve leaks for any reason sufficiently to drain the water in the discharge column before starting time, the priming water will be lost and the pump may be damaged if run without water. For this reason a priming switch is mounted above the pump. If the water in the column pipe is above the priming device, the float will be up, the priming switch will close, and the pump can be started. If there is not sufficient water in the discharge pipe to insure the pump being primed, the float will be down, the priming switch open, and the pump cannot be started. The foot valve is troublesome in acid water.

Priming by exhausting the air from the pump casing and suction is accomplished by use of a motor-driven vacuum pump, connected to the highest point of the pump shell through a float chamber which has an attached float switch, Fig. 17. After the air has been exhausted from the pump casing, water rises in the suction pipe, through the pump, and into the float chamber; the float is lifted, the priming switch closes, and the pumping unit is started.

Fig. 18, A and B, illustrates a Hazleton suction-line primer combining a strainer, a check valve, and an air pump in a single casting. Other arrangements embody a storage tank of proportional volume with pump and suction so as to fully exhaust the air after two or three starts of the pump.

A pump with suction head has dependable priming and is always ready to operate. It is started by a priming float and switch attached to the top of the casing. When the water in the dam has reached a predetermined high level, the float chamber is filled, the float rises, closes the priming switch, and the pump is started. The pump motor can be stopped by a check valve or limit float switch.

While the pump is idle, the priming valve is held open by a spring to let the water rise through the valve and into the float chamber on a level with the water in the dam. After the unit has started, the pressure from the pump closes the priming valve and the float chamber drains slowly.

Fig. 19 shows automatically controlled pumps in series lift at the Burra Burra mine of the Tennessee Corporation (June 12, 1931, *E.&M.J.*). The Hudson Bay Mining & Smelting Company has two 250-g.p.m. centrifugal pumps fully controlled automatically; one under a head of 550 ft. and the other 925 ft., showing the field for automatically controlled centrifugal pumps of small capacity for high heads.

The cost of automatic control equipment depends chiefly on the equipment used. For small motors up to 30-hp., simple cross-the-line starters connected to a float switch with foot-valve priming are in general use. This equipment is slightly less expensive than manually operated equipment. For larger units, the approximate prices of automatic equipment are as follows:

From 220- to 440-volt electric priming pump, 15 to 50 cu.ft., $200; priming valve (spring operated), $12; No. 2 vacuum breaker with two-pole switch, $85; pressure regulator, $20; float switch to start and stop unit, $16; high-water alarm switch, $32; relay panel, $315; 6-in. extra-heavy bronze-fitted check valve and switch, $160; and bearings, heat-control switch, each $55.

Other equipment that is more variable in price, depending on the specifications, includes: automatic starters, 150-hp. induction squirrel-cage 2,300-volt a.c. motor. The magnetic starters complete with 2,200 to 220-volt transformers for control circuits, $570, or approximately one and one-half times the cost of a hand starter. The oil-inclosed type (for the same duty as the above) starter complete with high-voltage compensator, with inrush arranged for low-voltage release with ammeter equipment, compensator oil, and necessary voltage transformers, $1,150; or approximately three times the cost of a hand starter.

(To be concluded)

Table III—Solution No. 1

Purchase Cost of Pump	Cost of Pump Room at $0.20 Per Cubic Foot	Items 1–2 6% Int. Plus 10% Yr. Payment — 16%	Efficiency and Cost of Power	Yearly Maintenance Per Million Gallons	Total Yearly Cost
Centrifugal.....	.....	.....	70%	$5.00	.....
$2,100.....	$180	$364.80	$5,856.20	$766.50	$6,987.50
2 — 500 Triplex..	.....	.....	85%	4.00	.....
$10,200.....	$1,433.60	$1,861.38	$4,822.75	$613.20	$7,297.33
Yearly difference in favor of the centrifugal pump.....					$310.83

Table IV—Solution No. 2

Purchase Cost of Pump	Cost of Pump Room at $0.20 Per Cubic Foot	Items 1–2 6% Int. Plus 10% Yr. Payment — 16%	Efficiency and Cost of Power	Yearly Maintenance Per. Million Gallons	Total Yearly Cost
Centrifugal.....	.....	.....	40%	.....	.....
$1,225.....	$83.20	$209.31	$1,024.83	$76.65	$1,310.79
Triplex.....	.....	.....	80%	.....	.....
$1,550.....	$183.60	$277.38	$512.42	$81.32	$851.12
Yearly difference in favor of triplex.....					$459.67

Alloy Steels Score Advance

A SURVEY of the types of steel used by almost every important industry indicates that chromium steels are more widely employed than ever. The tendency is to use them more for heat-resistant and corrosion-resistant applications and for added strength in structural applications. Certain modifications of analysis are making many of them more valuable.

Modifications of the widely used 4 to 6 per cent chromium steels include a molybdenum-bearing 9 per cent chromium steel suitable for severe service in power plants and elsewhere. For high-pressure service, good results are obtained with 1.50 to 2.75 per cent chromium and the addition of molybdenum and vanadium. Another modification is a columbium-bearing 2 per cent chromium steel. The 4 to 6 per cent chromium steels themselves have been improved by adding columbium or titanium. The creep strengths of 4 to 6 per cent chromium steels containing tungsten or molybdenum are improved when columbium is added.

Addition of columbium or titanium is responsible for much of the improvement in many of the chromium-nickel and straight chromium steels. The prime function of columbium is to control the carbide constituents of chromium steels. It is effective in overcoming or modifying their air-hardening properties. In the past year columbium-bearing chromium steels have aroused favorable comment, especially among those interested in products fabricated by welding.

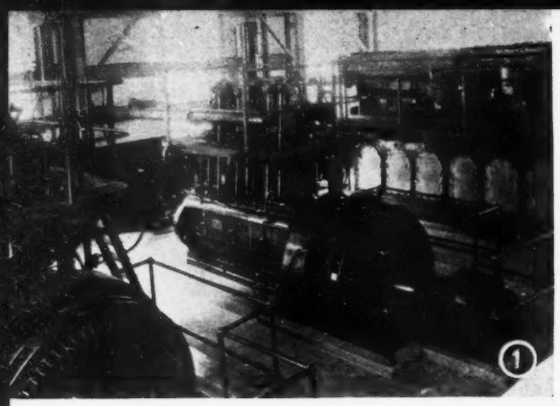
Columbium is used in 18-8 chromium-nickel stainless steel welding rods, and either columbium or titanium in the stainless base metal to inhibit any tendency toward intergranular corrosion that might otherwise be present in or near welds. With correct amounts of columbium it is not necessary to anneal structures fabricated by welding in so far as obtaining freedom from intergranular corrosion is concerned.

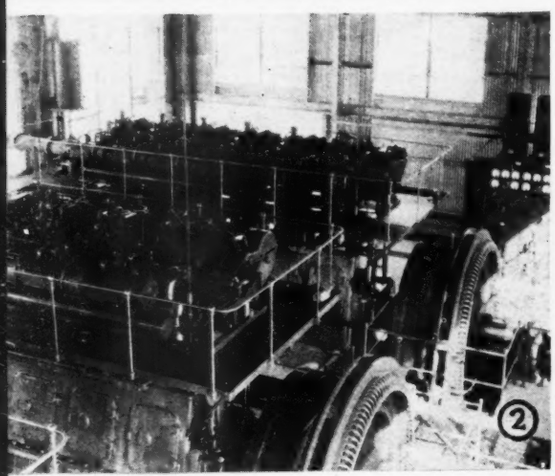
Among the important modifications of the straight chromium, oxidation-resistant steels is a new heat-treatable alloy containing 16 per cent chromium and 1 per cent nickel, used in airplane construction. Still new to many is the 18-8 type of chromium-manganese steel.

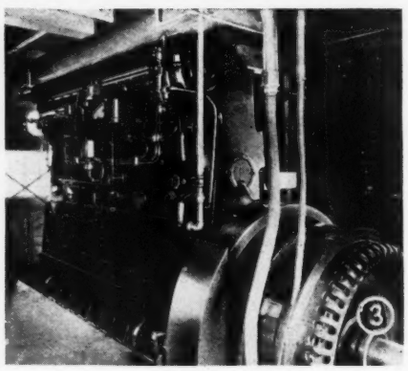
Analyses of many heat-resistant steels containing 20 to 35 per cent chromium have been modified. A new alloy containing 35 per cent chromium and 7 per cent aluminum is suitable for continuous service at as high a temperature as 2,300 deg. F.

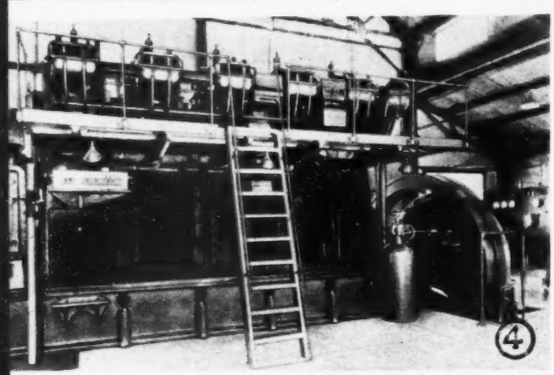
Another important modification of the high-chromium steels is the addition of nitrogen to improve the grain structure of steel castings containing over 20 per cent chromium. Nitrogen is added also to chromium steel ingots and to castings, and imparts a fine grain.

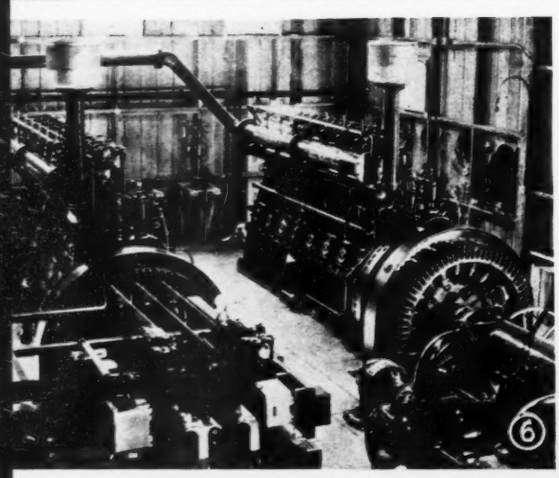
A Power Anniversary

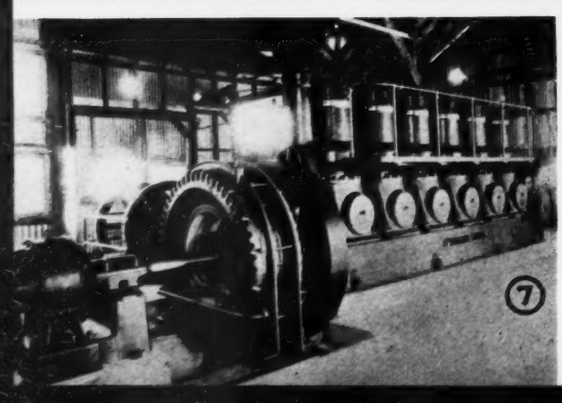












1 IN THE POWER HOUSE of Cia. Min. Kildun y Anexas, San Luis Potosi, Mexico. Three Ingersoll-Rand diesel engines totaling 1,300 hp.

2 AT KIMBERLY, NEV. — Three 600-kw. Busch-Sulzer units operated by Consolidated Coppermines

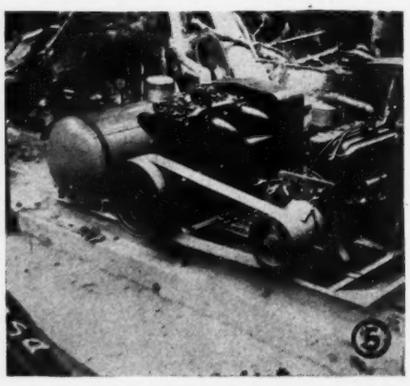
3 AT FREEPORT, LA., the Freeport Sulphur Company is running an a.c. generator with this 350-hp. I.-R. diesel

4 A FIVE-CYLINDER DIESEL, of Fulton make and developing 500 b.hp., in the plant of the Limestone Products Corporation at Newton, N. J.

5 A SMALL UNIT. At Paracale, in the Philippines, the Santa Rosa company is operating this Buda-Diesel driven air compressor

6 AT THE AZURITE MINE, at Mazama, Wash., the American Smelting & Refining Company has these two 400-hp. eight-cylinder Chicago-Pneumatic diesel engines

7 IN ARIZONA, the Pioneer Gold Mine, at Chloride, is operating this diesel-driven 375-kva. alternator. The driving end is a 2-cycle, 6-cylinder Fairbanks-Morse engine

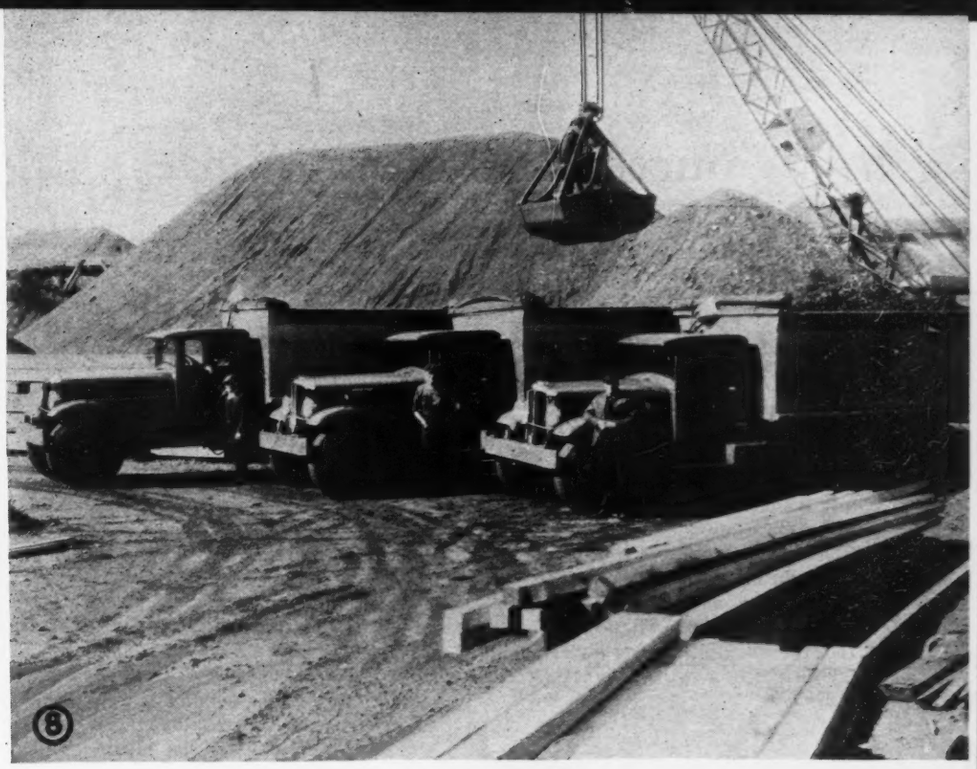


Rudolf Diesel's great invention, perfected by his successors, comes into its own 40 years after its introduction in America.

RECOGNITION by industry of the efficiency and economy of the diesel engine has been slow in coming, but it is now a shining fact. Sales figures tell the story. Some twenty years elapsed after the purchase of the American license by Adolphus Busch in 1896 and the construction of the first unit a little later, before the horsepower sold per year attained the 100,000 mark; and less than half a million horsepower had been sold in any year up to the depression. In 1932 sales dropped almost to their low point of seventeen years before. Then came revival. Annual horsepower sold rose to 750,000 in '34, passed the million mark in '35, and is estimated to have exceeded two million in 1936. And now life begins at forty. Application of this type of prime mover to mobile purposes is held accountable for much of the great increase. Trucks and tractors have taken a large part of the horsepower recently built. Of these the mining industry is absorbing a growing share, and is also proving the diesel increasingly useful for power generation. The accompanying illustrations bear witness.

To honor the memory of Dr. Rudolf Diesel and to celebrate the great success of his invention, industrial leaders came together at a special luncheon given on Dec. 7 at the Waldorf-Astoria in New York. Speakers well known in the business world paid their tribute to the inventor, whom fate willed never to see his invention succeed and to receive the world's acclaim. Their remarks were broadcast throughout the country to the public and to other special meetings simultaneously held. This occasion was part of the program of the National Exposition of Power and Engineering then in session in the metropolis.

DR. RUDOLPH DIESEL
celebrated inventor of the form of power that bears his name



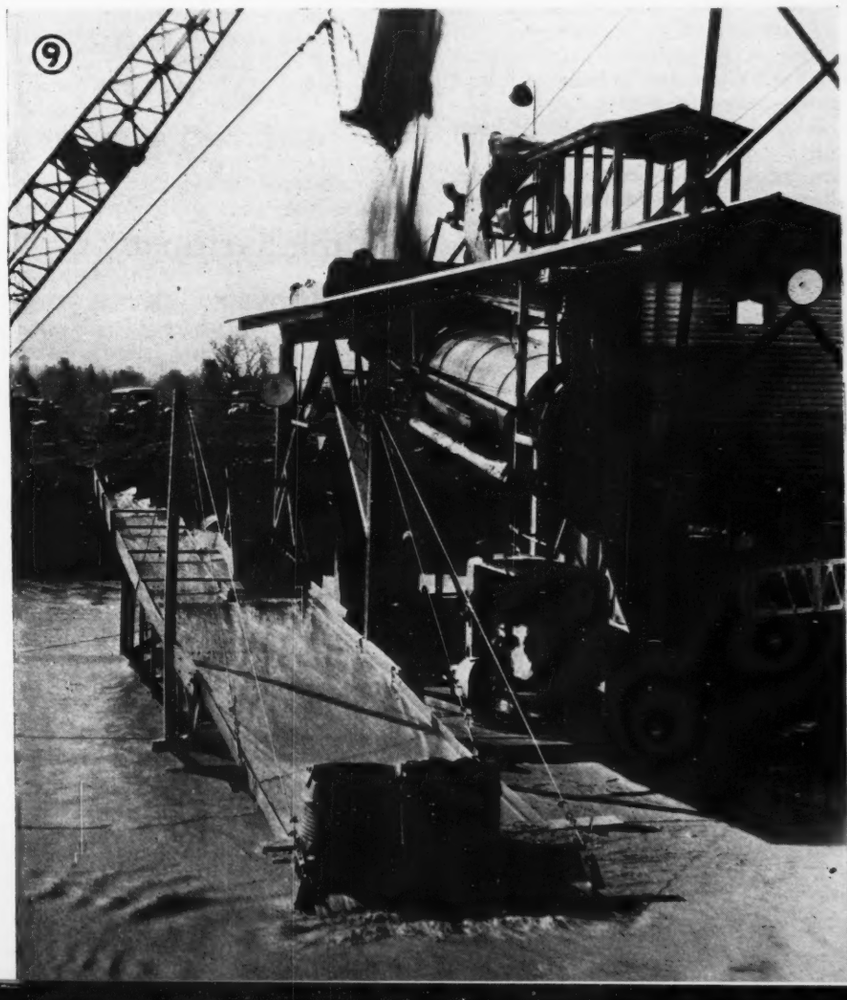
8 THESE TRUCKS, in service for hauling ore and tailings, are each powered with a Cummins Model H diesel engine

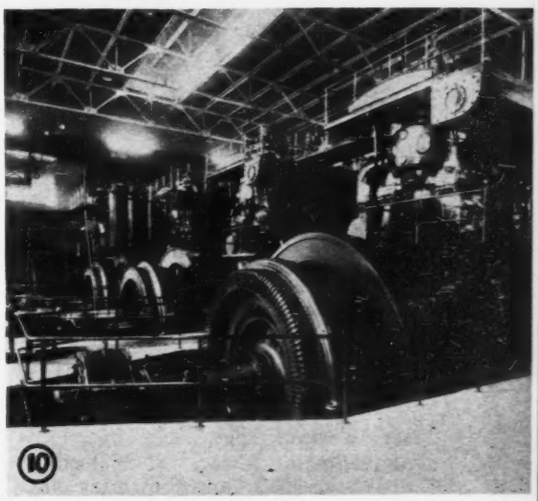
9 AT THE FAY GOLD PLACER, in California. The scow-mounted washing plant, the dragline that feeds it, and a tractor are all powered with Caterpillar diesels

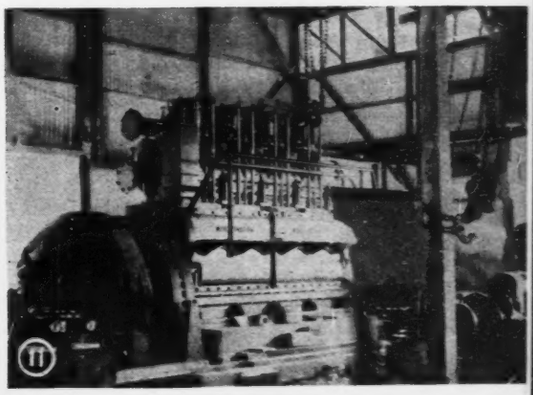
10 A LARGE INSTALLATION — Four diesel engines of Nordberg design and manufacture and totaling 10,750 hp., in the power plant of the Commerce Mining & Royalty Company, at Cardin, Okla.

11 IN THE PHILIPPINES this 300-hp. Worthington diesel has been placed in commission in the last few months by the East Mindanao Mining Company, on the island of Cebu

12 A TRACTOR, powered with a Caterpillar diesel, does heavy duty over snow-covered roads in Alaska





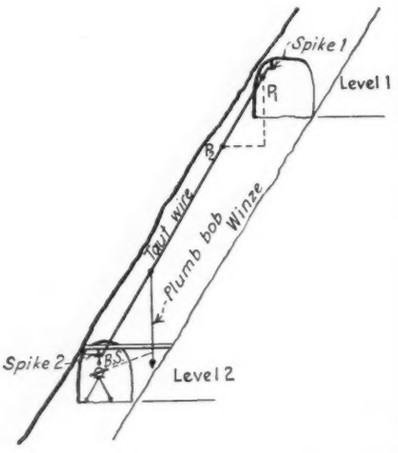


Surveying a Steep Winze Without an Auxiliary Telescope

Claude Ferguson and *K. J. Benner*

Veraguas Mines, Ltd., Colon, Panama

THE FOLLOWING METHOD has been successfully used by the authors recently for surveying a steep winze with a transit which was not equipped with an auxiliary telescope. The method, if the work is carefully done, is one of reasonable accuracy within the limits of its application, say for slope distances of not over 150 ft., this limit being determined by the distance a wire may be stretched



taut without appreciable sag. No originality is claimed for the method; it has probably been used by many other surveyors, but its presentation at this time may prove of help to some young engineer who finds himself confronted with a similar problem.

Referring to the accompanying sketch: Securely set, either in solid timbers or in plug holes in rock, Spike 1 and Spike 2, capable of withstanding the strain of a taut piano wire, and stretch the wire from one to the other, through notches in the spikes. The wire may follow any path down the winze provided it does not touch at any point between the spikes. The lower spike must be so placed that a set-up may be made under it.

Set up under a station on the upper level from which as much of a stretch of the wire may be sighted as possible, and shoot in Spike 1 and a point on the wire as far from the spike as it can be seen. If by chance Spike 1 cannot be sighted from the instrument, it will be necessary to shoot in two points on the wire, P1 and P2. Compute the coordinates and elevations of P1 and P2. With these data, the horizontal distance and the bearing, P1 to P2 may be computed. Having the horizontal distance and the difference in elevation between the points, the slope distance and vertical angle between them may be computed. It will be seen that the bearing will also be the bearing from P1 to Spike 2; likewise, the vertical angle will be the same.

With the tape, measure the slope distance P1 to P2 and P1 to Spike 2. We now have the bearing, vertical angle, and slope distance, P1 to Spike 2, whence the coordinates and elevation of the latter may be computed.

All that remains is to secure a back sight after setting up under Spike 2, and this is done by suspending a plumb bob from a point on the wire, as shown in the sketch. This bob, even though it causes the wire to sag, will hang in the plane passing through the wire and the center of the instrument and hence any point on the string will give the same backsight as though P1 were sighted. We are now ready to shoot in stations on the lower level.

Aside from careful work, accuracy will depend in a large measure on the distance between P1 and P2; it should be as great as possible. Points on the wire may be made of bits of wire solder, pinched on with pliers. The point from which the plumb bob is hung may be a bit of solder fused to the wire. Obviously, the bob should not be hung until the work on the upper level has been done and measurements have been taken. The tape measurement, P1 to P2, will check the computation of the same distance, and the slope of the wire may be checked roughly with a Brunton or other clinometer.

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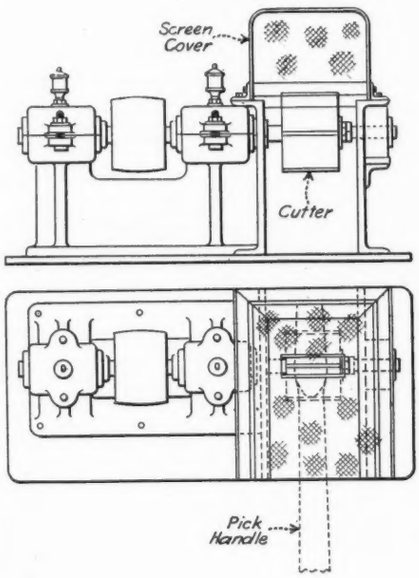
Wood Planer Homemade

A SIMPLE PLANER made entirely from scrap material is speeding repairs on mine picks, shovels, and hammers at the drill repair shop of Phelps Dodge Corporation, United Verde Branch, Jerome, Ariz., according to A. L. Gallardo, foreman. Prior to the installation of this machine wooden handles of hammers and excavating implements were adjusted manually, the repair man using the conventional coarse rasp or small adz. Progress was slow and the work was not always satisfactory. Loose handles often resulted.

The demand for speedier and better adjustment of wooden handles led to the development of the small planer shown in the accompanying sketch. It consists essentially of a cast-iron base, three bearings, a steel shaft with a three-blade cutter and a small pulley, and a cast-iron table plate resting upon two short pieces of 12-in. channels and covered with a screen hood. Planing of the handle ends to fit the aperture in the hammer, pick, or shovel is a matter of seconds. As mentioned previously, all parts were made from scrap material. The twin bearings, for instance, were taken from an old grinder, and the shaft and cutter were turned in the lathe from old steel shafts.



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A Cable Gripper

TO PROVIDE additional safety at the pit where two Marion 4½-cu.yd. electric shovels have recently been installed for loading copper ore and waste, the safety department of the Phelps Dodge Corporation's New Cornelia Branch, at Ajo., Ariz., has devised a simple and inexpensive cable gripper. The cable reel proper is carried in a cable boat towed by the shovel, and 2,400 volts are carried by the insulated cable. At the pit, use of this gripper has protected shovel operators from possible electric shock as well as reduced injuries to fingers and hands to a minimum. Essentially it consists of a forged steel-head fashioned after a pair of tongs, and two wooden handles secured to the shanks of the tongs by four small bolts. It is operated by a short manila rope attached to the ends of the handles.

The Problem of Measuring Settling Rates Of Mineral Suspensions

With Data on the Flotation of Quartz

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IN THIS PAPER is presented the problem of measuring settling rates of mineral suspensions, the settling-rate data for quartz, and data on quartz flotation. The study suggested itself several years ago to the senior author as a result of his belief that surface reactions in an aqueous mineral suspension are bound to be reflected in a change in the settling rate of the suspension substance and that surface reactions and flotation phenomena are definitely related. It was hoped, too, that the study would produce data that would refute or substantiate statements that have appeared from time to time in the literature relating to mineral floatability and surface ionization[1] or mineral floatability and flocculation[2] or dispersion.

At the outset of the study we assumed as a working theory: (1) that surface reactions (molecular or ionic alterations on the mineral surface or in the mineral lattice at the surface) are accompanied by a change in settling rate of the suspension; (2) that a state of high stability (slow settling rate) indicates surface ionization of the suspended particles, and (3) that instability (rapid settling or granulation) is indicative of little, or zero, surface ionization. It was further considered that the reactions involved were not unlike those involved in ionization of polar molecules, hydrolysis, and precipitation.

The data here presented are only a few of many which have been collected over a period of six years. Their acquirement has been time-consuming and tedious, but still they are not complete. An infinite number of problems have suggested themselves.

Problem of Measuring Settling Rates. This will not be gone into deeply; suffice to say that the problem of obtaining accurate settling-rate data is practically impossible of solution; at least, we feel this statement is justified on the basis of our own studies and from a study of the literature. Many methods and procedures have been proposed and tried; none was wholly satisfactory. Prerequisites in any methods are (1) cleanliness and purity of reagents, (2) skillful technique, and (3) temperature control.

For our work we wanted (1) a method sensitive and accurate enough to detect small changes in settling rates, (2) a method by which duplicate tests could be expected to check within acceptable limits, and (3) a method that was reasonably rapid. Some four to six months' time was devoted to study and developing of a method, and to technique.

Methods and Technique.—Three methods of measuring settling rate have been developed and used at different times in the course of the work. For present purposes these will be designated as (1) The siphon method. (2) The displacement method. (3) The photo-electric method.

Apparatus used in the siphon method, Fig. 1, consists of a footed cylinder and a glass siphon. The same cylinder was used in all tests. The siphon is made from small-bore glass tubing and the tube is rigidly fastened to a metal head which rests on the top of the cylinder. Because the siphon tube is of small bore, it causes a relatively slow discharge and avoids setting up eddy currents in the pulp.

In employing this method, the empty cylinder and the various solutes to be used are placed in a constant-temperature bath until they reach the temperature of 25 deg. C. Usually, six or eight tests are made at a time, and the different solutes (200-c.c. portions) are kept in stoppered flasks in the water bath until ready for the test. In making an individual test, one of the solute portions and two grams of quartz are placed in the cylinder, agitated by a standardized motion for one minute, and the cylinder is then placed in the water bath. The primed siphon is then inserted, and the cylinder allowed to stand undisturbed while the settling of the mineral particles takes place. At the end of the settling period, the pinch clamp on the rubber nipple at the end of the siphon is opened, and the upper portion of the pulp is siphoned off into a beaker. The cylinder originally contains 200 c.c. of liquid, and of this the siphon removes about 180 c.c. It takes about 50 seconds for the siphon to empty.

The pulp remaining in the bottom of the cylinder is filtered on a tared filtering crucible, washed, and dried, and the "per cent remaining suspended" (the weight of mineral carried over by the siphon) determined by difference. It is this "per cent remaining suspended" which is plotted in all of the curves in this paper as the variable which measures the stability of the suspension; the greater this quantity, the more stable is the suspension. A portion of the pulp siphoned out is filtered through filter paper and used for determining the pH of the pulp.

Equipment used in the displacement method, Fig. 2[3], comprises a tall liter beaker, for holding the material to be tested, and a graduated, loaded hydrometer equipped at its bottom with a disk-shaped pan. In making a test, the beaker is filled to a marked level with the mineral-water suspension to be tested. Then the hydrometer, held at the top by the thumb and finger, is inserted into the medium and given a standardized pumping action; this is to effect thorough suspension of the mineral powder. The hydrometer is let loose and allowed to float in the medium. The time required for it to settle a prescribed distance is recorded with a stop watch.

Absolute accuracy of the method depends upon a multiplicity of factors, the most important of which is the effect of density change of the liquid. No claims are offered for this method other than that the relative accuracy of con-

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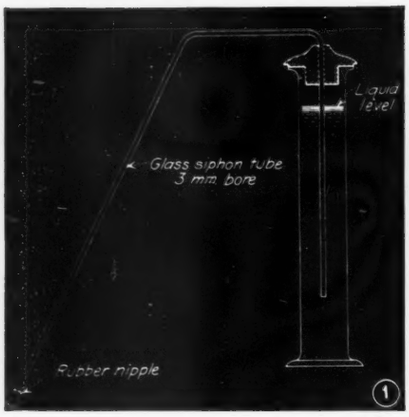
† Also Assistant Metallurgist, Idaho Bureau of Mines and Geology.



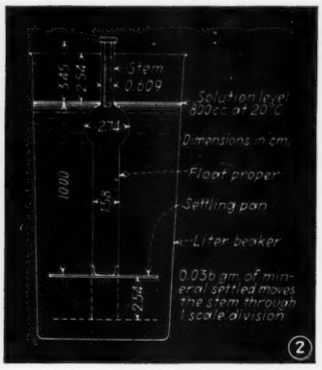


Fig. 1—THE SIPHON METHOD of making the sedimentation tests involved the use of the footed cylinder shown at the left and a siphon made of small-bore glass tubing rigidly fastened to a metal head resting on the cylinder

Fig. 2—THE DISPLACEMENT METHOD of making the sedimentation tests employs as apparatus a tall liter beaker for holding the material to be tested, and a graduated hydrometer having a disk-shaped pan at its bottom

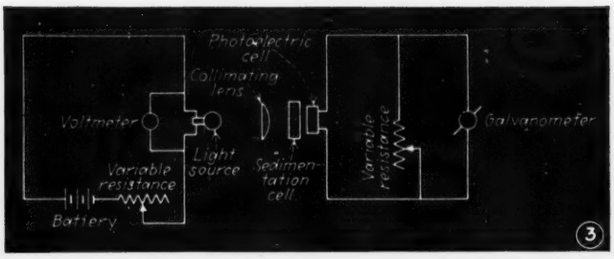


Fig. 3—THE PHOTO-ELECTRIC METHOD of making the sedimentation tests uses the principle of the photo-electric cell and the fact that, as any suspension is allowed to settle, its opacity decreases

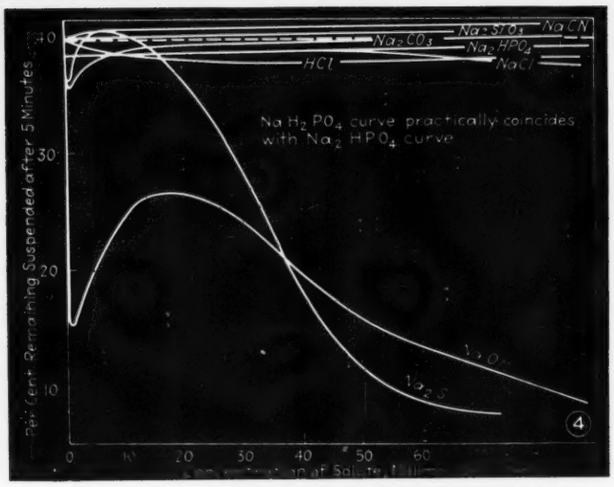


Fig. 4—QUARTZ SEDIMENTATION CURVES. The particular quartz used is strongly dispersed (highly stable) in distilled water

secutive readings permits the deduction of a characteristic settling curve. The rate of settling or velocity of particles is equal to a constant times the reciprocal of time of settling or $V = K\ t^{-1}$. The accuracy of the characteristic curve would not be increased by evaluating K; hence, the curves are plotted with reagent concentrations in millimols per liter as the ordinates and the reciprocal of the settling period in seconds as the abscissae.

All measurements were carried out in a thermostatically controlled water bath. The settling range was so chosen that the measurements were representative of the whole range of particle sizes down to near colloidal dimensions. The coarser particles settled during one-half the range of the stem. This period of settling varied from 30 seconds to 60 seconds over all the tests.

The photo-electric method, Fig. 3[4], makes use of the principle of the photo-electric cell and the fact that as any suspension is allowed to settle, its opacity decreases. From this it follows that the amount of light that is transmitted after a given time through a given column of suspension is a measure of the amount of solid still in suspension.

In employing the method a source of light of constant intensity is directed at an absorption cell in which is contained the suspension being studied. Immediately behind the absorption cell is a photo-electric cell connected through a shunt to a wall-type galvanometer. By allowing the suspension to settle a definite length of time, and then recording the amount of light transmitted, a measure of the stability of the suspension may be computed.

The procedure in making a test was as follows: One gram of mineral was agitated for 40 seconds in a tall, footed beaker containing 100 c.c. of the solute, which previously was brought to a constant temperature in a water bath. The suspension was then poured into the absorption cell, a prismatic glass flask approximately 1x2 in. in cross-section by 4 in. high. The suspension was allowed to settle in this cell for 15 minutes, at the end of which time the light was flashed and the deflection of the galvanometer read.

The basis of this measurement is a law of optics known as Beer's or Lambert's Law. Mathematically, it is as follows:

$$I = I_o\ e^{-ut} \qquad (1)$$

Where I = Intensity of light incident on photo-electric cell

I_o = Intensity of light incident on adsorption cell

e = Base of Napierian logarithms

u = Coefficient of adsorption

t = Thickness of column through which light beam passes

Expressing (1) in logarithmic form—

$$-ut = \log \frac{I}{I_o}$$

Whence $ut = \log I_o - \log I \qquad (2)$

The quantity I of Equation (2) can be read directly from the galvanometer. I_o is constant except when colored solutions, such as a copper sulphate, are used. Under such conditions, it must be determined for each concentration. The thickness of the column of suspension, t, is constant throughout all the tests, and thus may be disregarded.

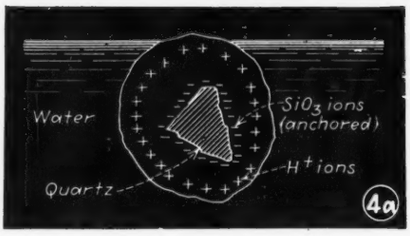


Fig. 4a—A STABILIZED QUARTZ PARTICLE in water. This schematic representation is based on the assumption that the dispersed quartz particle is surrounded by a hydrated ionic layer

It follows that the coefficient of adsorption, u, is some function of the amount of solid suspended. This relationship may be experimentally determined by selecting several values of u, percentage of solid still remaining in suspension. If y represents the per cent remaining suspended, this relationship between u and y is established as follows:

$$y = -120\ u + 120$$

The sensitivity of this method is limited only by the sensitivity of the various units. With proper care and standardization of technique, the method is more accurate than either of the two others used.

Quartz—The quartz used in these tests, with exceptions to be noted later, was of the white, massive variety commonly called "bull" quartz, obtained from a quartz quarry near Viola, Idaho. A large sample was ground to minus 80 mesh, digested with mixed nitric and hydrochloric acids, and then washed by decantation until pure white. Next the washed quartz was ground in batches for two hours in a porcelain pebble mill. The product from this mill was again washed with distilled water and dried. The part of the sample that passed a 400-mesh sieve (38 microns) was used in the sedimentation tests.

Water—This particular quartz is strongly dispersed (highly stable) in distilled water. Referring to Fig. 4, the stability is indicated by the horizontal dashed line passing through the ordinate 39; that is, it has a stability factor of 39. This value is of significance only in this set of experiments. It varies with the fineness of the quartz sample, the period of settling, the weight of solids used in the tests, and, as we have found out more recently, to some extent with the source of the quartz and the manner of preparing the sample.

On the theory that suspension stability is the result of surface ionization, speculation is in order as to the nature of the surface substance whose ionization is causing dispersion. Silica is said to form at least two hydrates, orthosilicic acid, H_4SiO_4, and metasilicic acid, H_2SiO_3, but some investigators believe that the definite compounds corresponding to the formulas given do not exist, and that $xSiO_2.2yH_2O$ and $xSiO_2.yH_2O$, where x and y are approximately of the same value, more closely fit the facts.

In the absence of facts, and for the purpose in hand, the surface substance may be considered to be either orthosilicic or metasilicic acid. Metasilicic acid is listed in handbooks as insoluble and orthosilicic acid as slightly soluble in water; soluble in alkalies and decreasingly soluble[5] in acids. For the discussion to follow, the surface substance is assumed to be metasilicic acid. If orthosilicic acid were assumed, the discussion would be equally appropriate.

Aged distilled water is acidic due to absorption of carbon dioxide forming the theoretical carbonic acid. The pH of our distilled water was closely 6.6.

Ionization of the quartz, then, may be attributed to carbonic acid or to water, or to both. The reversible reactions involved are indicated as follows:

$$H_2CO_3 \rightleftarrows \boxed{CO_3^{--} + \left|\begin{matrix}H^+\\H^+\end{matrix}\right| + SiO_3^{--}} \rightleftarrows H_2SiO_3 \quad (1)$$

The hydrogen cation is in the position of being vied for by both the carbonate ion, CO_3^{--}, and the silicate ion, SiO_3^{--}. Equilibrium and the number of the respective ions involved is determined by the ionization constants of the weak acids, H_2CO_3 and H_2SiO_3, which are as follows:

$$K_1(H_2CO_3 \rightleftarrows H^+ + HCO_3^-) = 3\times10^{-7}$$
$$K_2(H\,CO_3^- \rightleftarrows H^+ + CO_3^{--}) = 6\times10^{-11}$$
$$K_1(H_2SiO_3 \rightleftarrows H^+ + HSiO_3^-) = 10^{-9}$$
$$K_2HSiO_3^- \rightleftarrows H^+ + SiO_3^{--}) = 10^{-13}$$

The same kind of situation may be indicated for water,

$$H_2O \rightleftarrows \boxed{OH^- + \left|H^+\right| + SiO_3^{--}} \rightleftarrows HSiO_3^-$$

The ionization constant for water is

$$K_1(H_2O \rightleftarrows H^+ + OH^-) = 10^{-14} \quad (2)$$

Quartz is negatively charged in water and it is assumed that $HSiO_3^-$, or possibly SiO_3^{--}, is anchored in the quartz lattice.

In any event it may be assumed that the quartz particles are surrounded by a hydrated ionic layer which may be imagined to look as illustrated in Fig. 4a.

The hydrogen ions are held in the ionic envelope under a restraint measured by the ionization constant of the surface substance. Inasmuch as any environment capable of altering the ionization constant affects suspension stability, as will soon be shown, it is concluded that for complete suspension stability (dispersion) there exists what may be called a "critical ionization," the value of the constant of which may be somewhere between 10^{-9} and 10^{-14}.

Now, on the assumption that Fig. 4a depicts the "state of the union" at a quartz-water surface, it follows that any solute (ion) capable of disturbing the stability of the quartz suspension will need to possess the property of altering

Fig. 4b—SETTLING CURVE obtained when sodium hydroxide was used as a solute for the same quartz as referred to in Figs. 4, 5, and 6. With an increase in concentration, a sharp precipitation takes place at first, then redispersion (as shown here), and then a slow but complete precipitation of the quartz suspension (as shown in Fig. 4)

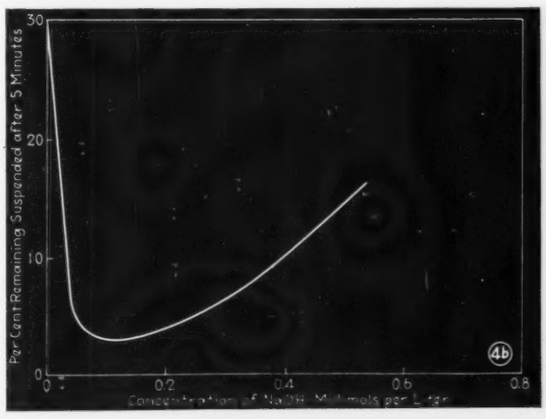


Fig. 5—Quartz settling curves for four solutes—calcium hydroxide, calcium chloride, calcium nitrate, and calcium chloride containing 5 millimols of hydrochloric acid, respectively

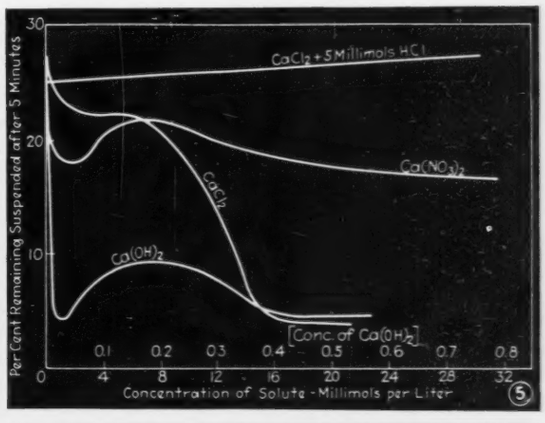


Fig. 6—Quartz sedimentation curves for seven solutes consisting of the nitrates of zinc, lead, calcium, copper, aluminum, and iron respectively

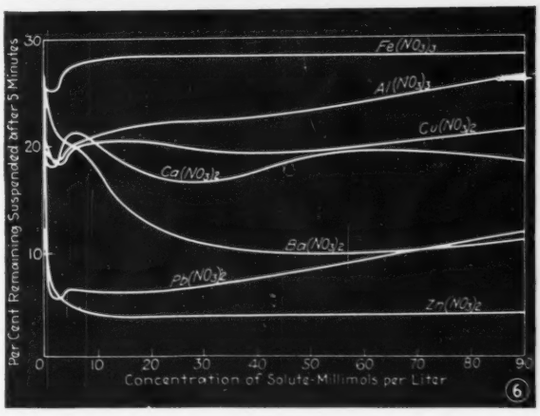
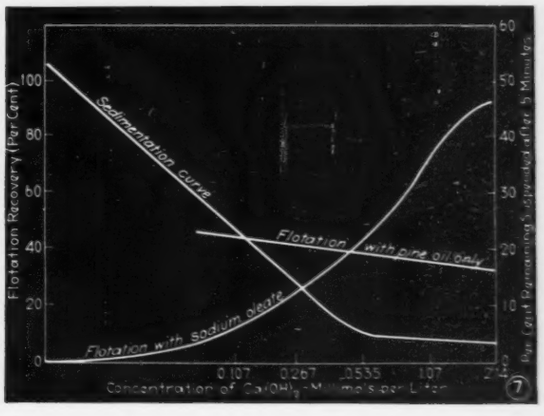
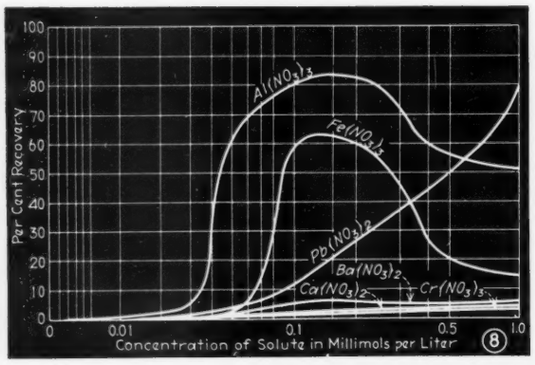


Fig. 7—Flotation tests on the quartz used in the sedimentation tests already described gave negative, or nearly negative, flotation results, using sodium oleate and pine oil


Sedimentation curve
Flotation with pine oil only
Flotation with sodium oleate
Flotation Recovery (Per Cent)
Per Cent Remaining Suspended after 5 Minutes
Concentration of Ca(OH)2 - Millimols per Liter
7



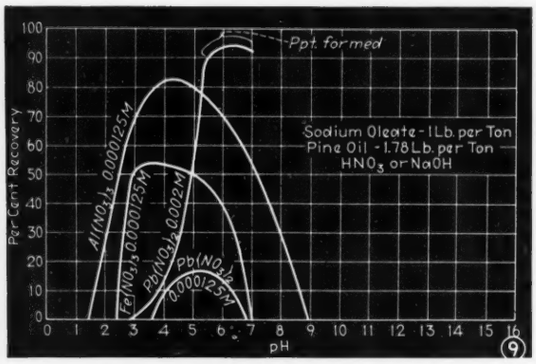
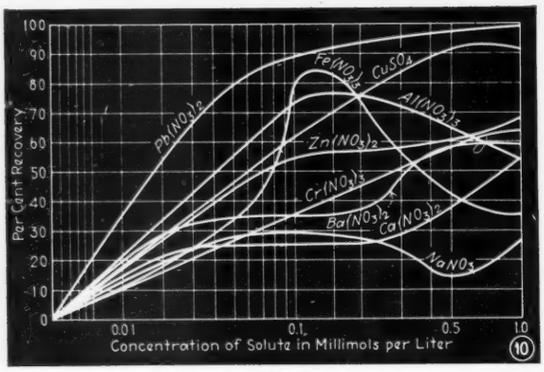


Fig. 8—Flotation recovery curve for minus 200 mesh, acid-washed, stream-boulder quartz from the vicinity of Moscow Mountain, Idaho, using the nitrates of the cations appearing on the settling curves of Fig. 6



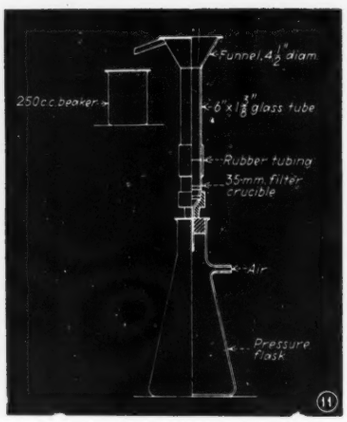


Fig. 9—THIS RECOVERY CURVE (for the same quartz as referred to in Fig. 8) shows the effect of the factor of pH on quartz flotation promotion properties of the various cations. See Table IV

Fig. 10—FLOTATION RECOVERY CURVES plotted from data obtained in tests similar to those which produced Fig. 8, save that the quartz was from a different source and was cleaned only with distilled water

Fig. 11—PNEUMATIC CELL, in sketch, used in making the flotation tests on quartz that are described in the accompanying tests

the ionization constant of the quartz surface-substance. It is well known in qualitative chemistry that ionization of a weakly ionized substance may be suppressed by adding a solute containing a common ion. Hence, ionization of a weak acid may be suppressed by adding an acid, and ionization of a weak base by adding a base containing the common ion OH^-.

Settling data[6] for the particular quartz described in the foregoing are presented in Figs. 4, 5, and 6. Here the per cent remaining in suspension after 5 minutes, which is a direct measure of stability, is plotted on the y-axis as ordinates against solute concentration in millimols per liter on the x-axis as abscissa.

Fig. 4 includes settling curves of solutes that fall roughly into three classes, namely: (1) The strong base, NaOH; (2) the strong acid, HCl; and (3) sodium salts of the so-called weak acids: Na_2S, Na_2CO_3, Na_2HPO_4, NaH_2PO_4, Na_2HCO_3, Na_2SiO_3, and NaCN. There also is a curve for the neutral salt, NaCl.

Sodium Hydroxide—Again, on this particular quartz,[7] sodium hydroxide gives a particularly interesting settling curve. With increase in solute concentration there is first a sharp precipitation (see also Fig. 4b), then redispersion, and then a slow but complete precipitation of the quartz suspension.

Let us now regard sodium hydroxide as a sodium salt of the weak acid HOH ($K_a = 10^{-14}$). Initial precipitation of the quartz is explained on the basis that HOH is more associated than silicic acid and the restrained outer H^+ ion held at the quartz water surface in the acid solution (Fig. 4a) is destroyed by association with OH-ions in accordance with the following reaction:

$$\begin{matrix} /O^- \\ Si=O \\ \backslash O^- \end{matrix} \begin{matrix} +H^+ \\ + OH^- \\ +H^+ \end{matrix} \rightarrow SiO_2 + 2\,H_2O \quad (2)$$

At the solute concentration giving maximum primary precipitation, pH = about 7, quartz[8] is presumably nearly insoluble and surface ionization is absent. With increasing solute concentration, redispersion (reionization) sets in, optimum redispersion being reached at a solute concentration roughly at 10 millimols per liter. It is presumed that this redispersion optimum corresponds to a critical solubility of quartz and surface ionization in which the silicate ion, SiO_3^{--}, is again the anchored ion and Na^+ the outer restrained ion. The final declining part of the settling curve presumably is due to mass action forces and to excess surface solubility.

Hydrochloric Acid and Sodium Chloride—Neither of these substances has any substantial affect on aqueous quartz suspensions. In view of the curves just discussed, the result was expected. Neither provides an anion capable of destroying the ionic envelope through H^+-ion association. That NaCl has no effect on the stability of a quartz suspension led further to the belief that sodium cation functions in the ionic envelope only in the presence of an anion (weak acid) possessing the ability to strongly associate with H^+-ions.

Sodium Salts of Weak Acids—In the light of the settling curves of Fig. 4 and in view of the dominant part played by H^+ and OH^- ions on the stability of aqueous quartz suspensions, these salts are best considered as a group. They are salts of weak acids and hydrolyze in accordance with the following equation:

$$Na^+ + A^- + H_2O = Na^+ + OH^- + HA$$

Ionization constants of the acids of these salts are shown in Table I.

Of this group, Na_2S is the only salt capable of precipitating quartz. Its curve resembles that of NaOH. There is a sharp, but limited, precipitation upon addition of a small amount of solute, then redispersion followed by a slow but complete precipitation of the quartz with continued additions of solute.

That the sodium sulphide settling curve is not unlike that of the NaOH is explained on the basis that H_2S and HS^- are strongly associated acids, possessing the power to remove (by association) hydrogen ions from the ionic quartz envelope. Since HS^- is a weaker acid than $H\,SiO_3^-$, H^+ ions are unable to hold a position in the restrained outer layer of the ionic envelope, and sodium, as in the case of hydroxide, has the call.

Sodium carbonate is a salt of an acid, H_2CO_3, considerably stronger than H_2SiO_3, and it has therefore no capacity to acquire, by association, the hydrogen ions of the ionic envelope; hence, it is assumed that in a sodium carbonate

solution (concentration within the limits of these tests) the ionic envelope engulfing quartz is ionized silicic acid, SiO_3^{--} being the anchored and H^+ the restrained ion.

Both phosphates, Na_2HPO_4 and NaH_2HPO_4, the first basic and the second acidic, are dispersants of quartz. With these as with Na_2CO_3, the acid H_3PO_4, from which they are obtained, is much more ionized than silicic acid and the H-ions of the quartz ionic envelopes are unmolested.

Sodium silicate, a basic salt, adds a common ion, SiO_3^{--}, and should not be expected to, and does not, affect an aqueous quartz suspension.

Sodium cyanide, according to the settling curve, is the strongest dispersant of quartz of the group listed. It is a uni-univalent salt and would appear to possess to better advantage than any tested the right combination of alkalinity and weak acid, to give critical ionization in the ionic envelope.

Calcium Salts—In Fig. 5 are shown settling curves depicting the effect of $Ca(OH)_2$, $CaCl_2$, $Ca(NO_3)_2$, and acidulated $CaCl_2$ on aqueous quartz suspensions. This group of reagents is fundamentally different from the group of sodium salts discussed in the foregoing. Silicate of the cation, Ca^{++}, is only slightly soluble in water, the solubility varying somewhat with pH, increasing in solubility with decreasing pH.

Calcium hydroxide, a strong base, is a strong precipitant of quartz. Precipitation being indicated in the reaction $H_2SiO_3 + Ca(OH)_2 \rightarrow CaSiO_3 + 2H_2O$.

Formation of $CaSiO_3$ is made possible both by insolubility of this silicate and through association of H^+ and OH^- to form water. This reaction is completed at a solute concentration of less than 0.05 millimols per liter.

$CaCl_2$ and $Ca(NO_3)_2$ are nearly neutral salts, and the settling curves depict the difficulties these reagents encounter in precipitating quartz. In the absence of hydroxyl ions, H-ions resist tenaciously the attacks of calcium cations and they give ground only to relatively high concentration of cations. When 5 millimols of HCl are added to the aqueous-quartz suspension, ionization of silicic acid is suppressed to a point of complete protection against Ca^{++} ions.

In the curves of Fig. 6 a new combination of elements is involved. Members of this group of salts, excepting calcium and barium, are of the type in which a weak base and a strong acid are involved. Here it seems that explanation of the destruction or preservation of quartz stability must relate to the solubilities of the hydrates and the silicates of the solute cations and to silicic acid. (See Table II.) If the hydrate of the cation is less soluble than silicic acid or than the silicate of the cation, little or no precipitation of quartz should occur. The $Fe(NO_3)_3$ settling curve provides data in support of this hypothesis. If the hydrate is more soluble than either silicic acid or the silicate of the cation, and if the silicate is less soluble than silicic acid, precipitation should result. Data in support of this theory are those for $Zn(NO_3)_2$. The zinc cation, in this case, is the best precipitant of quartz as seen from the settling curve for this cation. Zinc silicate is a highly insoluble silicate. The lead cation takes a close second to zinc, as it should in accordance with the data of Table II.

The hydrates of calcium and of barium are relatively highly soluble and hydroxyls have no call on these cations. The silicates of these cations have an appreciable solubility and they are therefore not potent precipitants of quartz. The slow, declining trends of their settling curves are evidence of this fact.

Flotation of Quartz—The quartz used in the sedimentation tests recorded, and other quartz samples from various sources, gave negative, or nearly negative, flotation results using sodium oleate and pine oil. The sodium compounds, including all those tried in the sedimentation tests, irrespective of the nature of the settling curves, displayed no quartz flotation promotion ability whatever.

The strong bases of the bivalent cations, Ba and Ca, are promoters of quartz flotation. Experimental data for $Ca(OH)_2$ are grouped in Table III and depicted graphically in Fig. 7. Using a constant concentration of oleate (1 lb. per ton), and floating in $Ca(OH)_2$ solutions of increasing hydroxide concentration, flotation recovery varies from zero in water to 94.1 per cent in a calcium hydroxide solution containing 2.14 millimols per liter. The $Ca(OH)_2$ settling curve also is shown on this figure. Flotation recovery increases as settling rate increases. Thus, in this case, flotation recovery and settling rate bear an unmistakable relationship. The nearly horizontal curve on this same figure is that of quartz flotation with $Ca(OH)_2$ and pine oil only. In view of this pine oil curve, it appears that in the absence of the base sodium oleate is a depressant. Sodium oleate added to the settling tests, however, had no measurable effect on the quartz settling rate.

In Figs. 8, 9, and 10, which appear on page 26, are shown the effects on the flotation of quartz, of nitrates of various cations—namely, those appearing on the settling curves of Fig. 6, which is shown on page 25.

The recovery curves in Fig. 8 are plotted data from tests on crushed, acid-washed, stream-boulder quartz from near Moscow Mountain. This is not the same quartz—that is, it is not from the same source—as the quartz used in the settling tests which produced the curves of Fig. 6.

The quartz recovery curves of Fig. 9 bring out strikingly the effect of the factor of pH on quartz flotation promotion properties of the various cations. In running these tests (see Table IV) the concentration of salt giving the highest recovery, when used alone, was used (amount being indicated on the curve) and the pH was controlled by additions of nitric acid or sodium hydroxide.

For this quartz, prepared as stated, $Al(NO_3)_3$, at any pH value, is the best quartz flotation activator using sodium oleate. The greatest flotation recovery by any of the cations tested occurs well on the acid side of neutrality; that is, below pH 7.

So far as this particular sample of quartz is concerned, it may be observed by comparing the curves of Figs. 6 and 8 that it is not those cations, Zn^{++} and Pb^{++} and Ba^{++} for example, giving the most depressed settling curves (flocculation) which are the best quartz flotation promoters. Al^{+++} and Fe^{+++}, two having the least flocculating action on quartz in water suspension, are the best promoters. Zinc nitrate precipitates quartz presumably through formation of insoluble zinc silicate, but fails to promote quartz flotation because zinc silicate is equally as insoluble, or even less soluble, than zinc oleate. If this reasoning is correct, then it follows that the iron and aluminum cations form slightly soluble silicates capable of reacting with sodium oleate to form the insoluble soaps of these cations.

Fig. 10 presents a group of quartz recovery curves plotted from data acquired from tests made in a manner and under conditions identical to those which produced Fig. 8. The quartz sample, however, was from a different source—namely, Warren, Idaho—and was cleaned only with distilled water, acid-washing being omitted. These quartz boulders were perfectly white, and, so far as could be seen by the eye, free from minerals. It is a better floating type of quartz, with any of the reagents, which may be attributed to either its own inherent properties or to the fact that it was not acid-washed. Here Pb^{++} is No. 1 promoter with Fe^{+++}, Cu^{++} and Al^{+++} close seconds. In both Figs. 8 and 10, the Al^{+++} and Fe^{+++} recovery curves pass through optima at solute concentrations only little more than 0.0001 moles per liter. Curves for the other cations, although irregular in spots, have a general rising trend. The fact that all recovery curves show zero recovery at zero solute concentration possibly leads to the conclusion that the unwashed quartz was not a source of activating cations.

In Fig. 11 is presented a sketch of the pneumatic cell used in making the flotation tests which are presented in this article

In Figs. 4, 4b, 5, 6, and 7 the solute concentration is plotted directly in millimols per liter. In Figs. 8, 9, and 10 a different scale is used, which may be given thus: If c = concentration in millimols per liter, then the abscissa is log (1 + c). Such a plot "opens up" the curves in the dilute solutions where changes take place most rapidly, but still permits the curves to approach the zero concentration ordinate. This latter would be impossible if log c were plotted instead of log (1 + c).

Summary and Conclusions

1. Quartz is fully dispersed in distilled water. The particles are negatively charged. The anchored ion is presumed to be SiO_3^{--} or $HSiO_3^-$ and the outer free-swimming or restrained ion, H^+

Table III—Flotation Recoveries of Quartz in $Ca(OH)_2$ Solution

A — Acid-washed bull quartz (—200 Mesh)

Concentration of $Ca(OH)_2$ Millimols per Liter	Per Cent Recovery 1. $Ca(OH)_2$ Alone	Per Cent Recovery 2. $Ca(OH)_2$ + 1 lb. per Ton of Sodium Oleate
2.14	31.5	94.1
1.07	37.1	75.0
0.535	32.5	42.3
0.267	46.5	27.0
0.107	40.6	8.9

B — Specimen (crystalline) quartz

2.14	7.6	77.4
1.07	4.8	64.0
0.535	14.3	30.9
0.267	13.4	15.0
0.134	18.7	
0.107		7.5
0.000	21.0	7.2

Table I—Ionization Constants

Salt	Acid	First H	Second H	Third H
Na_2S	H_2S	9.1×10^{-8}	1.2×10^{-15}	
Na_2HPO_4	H_3PO_4	1.1×10^{-2}	$2. \times 10^{-7}$	3.6×10^{-13}
$Na\ H_2PO_4$	H_3PO_4			
Na_2CO_3	H_2CO_3	3×10^{-7}	6×10^{-11}	
Na CN	H CN	7×10^{-10}		
Na_2SiO_3	H_2SiO_3	10^{-7}	10^{-13}	

Table II—Solubilities of the Hydrates and Silicates of Various Cations

Cation	Hydrate Solubilities in 100 Parts of Water	S Solubility Product	Silicate Solubilities in 100 Parts of Water
Zn^{++}	$Zn(OH)_2$, $0.00042^{18°c}$	5×10^{-17}	$ZnSiO_3$, insoluble
Pb^{++}	$Pb(OH)_2$, $0.016^{20°c}$	1.1×10^{-13}	$PbSiO_3$, insoluble
Cu^{++}	$Cu(OH)_2$, insoluble	1.7×10^{-13}	No data
Al^{+++}	$Al(OH)_3$, 0.00015	3.9×10^{-18}	$Al_6O_4.Si_2O_4$, v.s.l.s.
Fe^{+++}	$Fe(OH)_3$, insoluble	1.1×10^{-38}	No data
Ba^{++}	$Ba(OH)_2$, $8H_2O$ $3.48^{20°c}$		$BaSiO_3$, soluble $BaSiO_3.6H_2O$. No data
Ca^{++}	$Ca(OH)_2$. $0.185^{°c}$		$CaSiO_3$ (∝), $0.0095^{17°c}$

2. An aqueous quartz suspension is sharply precipitated by small concentrations of sodium hydroxide, partly redispersed with continued small additions of this reagent, and then slowly but completely precipitated. The initial sharp precipitation is presumed to be due to association of OH^- ions with outer layer of H^+ ions in the ionic envelope of the quartz particles. Redispersion or re-ionization of the quartz surface is attributed to Na cations, sodium silicate reaching a critical ionization at a solute concentration measured by the vertex of the curve. The particle remains anionic. The final depression of the settling curve is ascribed to common ion and mass action forces.

3. The salts of sodium in which the anion is the radical of a weak acid are precipitants of quartz only when the acid of the salt is less ionized than silicic acid. This deduction is made from the settling curve, Fig. 4, and the ionization data, Table I. Sodium sulphide (acid HS^-, k_2, 1.2×10^{-15}) is the only sodium salt of this class capable of precipitating an aqueous quartz suspension. Sodium cation is capable of occupying a position in the ionic envelope only in the presence of an anion strongly associated with H^+—these are OH^- and HS^-.

4. Calcium cation, Ca^{++}, is a strong precipitant of quartz only in the presence of hydroxyls. Hydroxyl anions associate with and remove hydrogen cations, and calcium silicate is formed which is less soluble in alkaline than in acid solutions. Ca^{++} does not precipitate quartz in acid solution for reasons the reverse of those just stated—that is, ionization of silicic acid is suppressed and calcium silicate increases in solubility.

Table IV—Quartz Flotation Recovery in Solutions of Various Metallic Nitrates, With Varying pH Values. (Control of pH Was Obtained by Addition of NaOH or HNO_3.)

pH	Recovery, per Cent
(0.000125M $Pb(NO_3)_2$)	
3.6	0.0
5.3	16.2
6.8	0.0
(0.000125M $Fe(NO_3)_3$)	
2.3	0.0
3.4	54.0
5.4	48.2
6.9	0.0
(0.000125M $Al(NO_3)_3$)	
1.4	0.0
2.3	40.1
4.5	82.2
7.7	40.0
8.9	0.0
(0.002M $Pb(NO_3)_2$)	
2.9	0.0
4.4	25.2
4.7	43.3
5.7	94.6
6.8	93.2

5. The effect of solute cations on the stability of aqueous quartz suspension appears to be related to (1) the solubility of the hydrate of the cation, and (2) the solubility of the silicate of the cation. If the hydrate of the cation is less soluble than silicic acid, the suspension is little affected; on the other hand, if the hydrate is slightly soluble but the silicate of the cation insoluble, precipitation occurs.

6. In a broad and general way the data of this paper unmistakably indicate that pH holds the upper hand on surface reactions involved in aqueous quartz suspensions.

7. Sodium salts, although NaOH and Na_2S are precipitants of quartz in certain concentration ranges, are not promoters of quartz flotation.

8. Calcium and barium hydroxides are precipitants of quartz in aqueous suspension and are also promoters of quartz flotation. Precipitation no doubt is due to formation of a surface layer of calcium silicate and then the addition of sodium oleate forms a surface of water repelling calcium oleate.

9. Base-metal nitrates, Ca^{++}, Ba^{++}, Al^{+++}, Fe^{+++}, Zn^{++}, Cu^{++}, and Pb^{++}, have widely different quartz flotation activating properties. The determining factors involved seem to be (1) relative solubilities of the hydrates of the cations, (2) the relative solubilities of the silicates of the cations, and most potent of all factors, as shown by Fig. 9, is (3), the pH concentration.

10. This research indicates that there is not necessarily any relationship between the state of a mineral (quartz) water suspension and the floatability of the mineral.

FOOTNOTE REFERENCES

[1] Taggart, Taylor, and Knoll: "Chemical Reactions in Flotation." Milling Methods, A.I.M.E., p. 241 (1930). Also S. J. Christman: "Chemistry of the Flotation Process." American Cyanamide Company. Tech. Paper No. 17.

[2] H. Livingston Sulman: *Trans.* A.I.M.E., 29, 49, (1920).

[3] From work done by H. Gordon Poole, Idaho Bureau of Mines Research Fellow, 1932.

[4] From work done by Robert H. Raring, Idaho Bureau of Mines Research Fellow, 1933.

[5] Lenker and Merril: *Jour. Am. Chem. Soc.*, 39, 2630 (1917).

[6] The voluminous tables of data are omitted to conserve space.

[7] Samples of quartz were also obtained from two other sources, one a quartz boulder from a stream near Moscow and the other a pure white, massive quartz obtained from the placer ground in the Warren, Idaho, district. The Warren quartz, prepared with or without acid treatment, could be made to show only a very minute initial dip in the settling curve with NaOH and the rate of depression of the settling curve in the higher solute concentration range was less rapid. These two samples of quartz also were less well dispersed in distilled water than was the Viola quartz. We have no explanations to offer to account for these differences in settling characteristics displayed by quartz from various sources.

[8] Numerous tests were made to follow the pH of the solution through this primary dip of the settling curve. There is dispersion on either side of the neutral pH of 7, but our technique was not delicate enough to determine if the minimum occurred at exactly 7.

[9] The flotation data presented in this paper are from unpublished work done by Donald Ingvoldstad, United States Bureau of Mines Research Fellow, 1936.

Erickson Detachable Bit

Proves Value At Lake Shore Mine

Product made in company's shops is light, rugged, simple, and cheap

A NEW TYPE of detachable bit has been developed by C. Erickson, foreman of the steel-sharpening shop of Lake Shore Mines, Kirkland Lake, Ontario, Canada. It has been described in an article on Lake Shore mining methods in an issue of the *Bulletin* of the Canadian Institute of Mining and Metallurgy.

Several types of detachable bit on the market were tried at Lake Shore before Mr. Erickson developed the idea of a loose-fitting bit held in a dovetailed slot in the steel shank and easily inserted or removed with the fingers. Features claimed for the bit are its lightness, ruggedness, simplicity, and cheapness. It is a straight cross bit with 95-deg. cutting angles and a 7-deg. straight taper, the thickness of the wings being $\frac{3}{4}$ in.

The first idea was to have the bit held in a straight slot with a cylindrical bottom of larger diameter. It was found that with this particular design upsetting took place either in the slot of the shank or in the base of the bit, thus making it difficult to insert or detach the bits, a difficulty finally overcome by the development of a straight dovetailed slot with a flat seat.

The bits are made from round billets of special drill steel heated to 1,850-1,950 deg. F. and forged to shape. After forging, they are normalized and ground to the required gage size. In the next machining operation, the base of the bit is dovetailed, and this is followed by the sharpening of the cutting points and the removal of any decarbonized material. The bits are then heated in automatically controlled electric furnaces, through which they are carried on conveyors timed to prepare the material properly for the hardening quench in water, accomplished by a quenching machine so designed as to cause a flow of water directly to the cutting points of the bits, thus assuring maximum hardness in the cutting edges without hardening the core. The height of the water during the quenching operation is so regulated as to limit the depth of hardness and to prevent the dovetail from becoming too hard. Bits are tempered after hardening and tested for hardness in a Rockwell machine. They must test over 60 Rockwell, or "file hard."

In forming the head of the shank, the steel is upset to give more bearing surface for the base of the bit and also to act as a pilot in preventing creeping of the bit while drilling. Quarter-octagon steel proves more suitable than the round section by providing more body to the upset. One bearing surface for the base of the bit gives fairly satisfactory results, but an improvement has been made by cutting a bevel to the slots to correspond to, and provide bearing for, the cross-wings of the bit, as well as the base. All corners have $\frac{1}{16}$ in. radius. The water hole of the shank is enlarged during forging operations to permit increased flow of water around the base of the bit. A total clearance of 0.014 in. between the sides of the dovetail and slot allows an easy flow of water to the face of the bit. A water hole through the bit is unnecessary, due to its small depth, and thus a weakened bit is avoided. The central hole on the face of the bit acts as a pocket to keep the bit central in the shank. Used bits can be reground once or twice.

Of the total footage drilled, at Lake Shore, 92 per cent is done with the Erickson detachable bit. Standard starters, necessary to collar holes for the use of the detachable bits, comprise 70 per cent of the total steel sharpened at present. The necessity of standard starters may be overcome by the use of a type of bit attachment now in the experimental stage.

Use of these bits at Lake Shore is proving satisfactory, but must be regarded in the nature of an experiment on a large scale. The results obtained from tests on a smaller scale were inconclusive. The drilling efficiency of the new bit is equal to that of a forged bit on standard steel. In a limited number of isolated cases of extremely hard ground, the loss of gage is more apparent. Reground bits are in general use in all stopes; in development, new bits are supplied in the larger sizes and reground ones in the two smaller sizes, due to the fact that current development is being done mainly where hard ground is being encountered.

In drilling a hole with reground bits, there is a slight drop in drilling speed after the first 10 or 12 in., which in a few cases is the limit of the run, although the full run of 18 in. is made in most others. Some reground bits, if not ground for gage, will tend to bind in the hole after 10 to 12 in., but those that have been overworked in the first instance are likely to be the ones giving trouble, due to the soft core having been exposed.

Grinding efficiency has shown a decided improvement recently, both in the number of bits ground per man-shift and in the life of the grinding wheels. One man produces about 600 reground bits per eight-hour shift, and one wheel has produced 7,500 bits before being discarded. The actual cost of grinding, including the handling and checking charges, amounts to 2.4c. per bit.

At present, 27,000 new and 41,800 reground bits are used monthly, with 17,000 standard steel, compared to 99,400 standard steel before the advent of the Erickson bit. These figures are brought out merely to indicate the reduced amount of handling, the difference in totals being accounted for principally by the reduction in the amount of development work now being performed. The high proportion of reground bits used results from an accumulation of used bits stored prior to any regrinding, while the feasibility of the bit was being tested. When second regrinding is in operation, the proportions in daily use should be 38.6 per cent new, 33.2 per cent reground once, and 28.2 per cent reground twice.

It has been found that 86 per cent of the original bits may be reground once and 73 per cent reground twice, the percentages taking into account the number of bits lost, broken, and scrapped. The cost of bits to the Lake Shore will amount to approximately 6.5c. per ton milled, and, including the sharpening of standard steel still in use, replacement of shanks, and other shop charges, the total steel costs should equal 12c. per ton milled, which is considerably less than steel-sharpening costs in the two years prior to using the Erickson bit. Some of the major economies have been made in the distribution costs through shafts and levels to the various working places, the saving in hoisting time being of great importance and becoming more apparent as greater depths are reached.

NEWS
OF THE INDUSTRY

Philippine Assembly Passes New Laws Affecting the Mining Industry

Gold Tax Is Based on Gross Value of Production

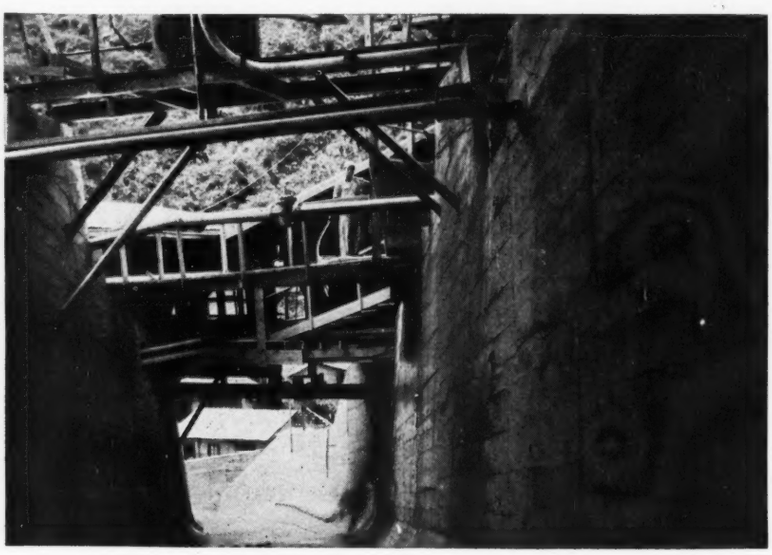
THREE new laws affecting the mining industry were passed by the Philippine Assembly at its first session in October, and signed by President Manuel L. Quezon early in November. One of these laws provides for the creation of a Bureau of Mines, similar to that of the United States; another, called the Securities Act, is for the purpose of regulating trading in mining stocks; the third, and most important, provides for the conservation, disposition, and development of mineral lands and minerals. The Securities Act will do much to curb the wild speculation which has been prevalent in the Islands for the past year. It is designed to control the activities of brokers, and to prevent, if possible, the manipulation of stocks to the detriment of the public. The taxation schedule of the new mining law provides that a royalty of 1½ per cent of the actual market value of the gross output of all mining operations shall be paid. This does not apply to gold production, however; royalties for gold mines are to be based on the annual gross output, without deducting milling and marketing costs, as is provided in the old law. Taxes based on the sliding scale of value of gold production follow:

Gross Value of Gold Production (Philippine Pesos)[a]	Tax Rate per Cent
1 to 500,000	1½
500,001 to 1,000,000	2
1,000,001 to 1,500,000	2½
1,500,001 to 2,000,000	3
2,000,001 to 2,500,000	3½
2,500,001 to 3,000,000	3½
3,000,001 to 3,500,000	4½
3,500,001 to 4,000,000	4½
4,000,001 to 4,500,000	4½
4,500,001 to 5,000,000	5
5,000,001 to 5,500,000	5½
5,500,001 to 6,000,000	5½
6,000,001 to 6,500,000	5½
6,500,001 and above	5½

[a] Philippine silver peso exchange = approximately 50.35c. United States currency.

Mines treating low-grade ores are given discounts. Where the average value of the ore is less than 10 pesos but not less than 7 pesos per ton, a 15 per cent discount is given; on ore of less than 7 pesos' value per ton, a 25 per cent discount is allowed. Placer mines are given a discount of 35 per cent on gross value of gold production. Mining companies pay registry fees, patented claims fees, recording fees, and sales tax, in addition to the usual indirect taxes such as customs duties on machinery, postage on bullion, taxes on mine purchases, etc. Operating companies pay production taxes, property taxes, income taxes as corporations, forestry taxes, real-estate taxes, and many other indirect taxes. The government collected about 1,055,000 pesos in taxes on gold production in 1935. In 1936 the gold tax collection is estimated to be double that of 1935. The outlook for 1937 is considered even more promising. Mining leaders have expressed themselves as being satisfied that the new legislation will work out for the best interests of all, although, of course, there are features that are not entirely what the industry desired.

✦ The shipping strike which has tied up the Pacific Coast has not as yet affected the Philippine mining industry to an appreciable extent. The larger organizations, forewarned of labor difficulties in the States, had laid in supplies sufficient for several months. Should the strike be continued for six months or more, however, a shortage of essential supplies is likely to be felt. Many new companies have ordered equipment from the States; such equipment, unless it can be moved through Canada, is of course being held up indefinitely. Sources of supply are being sought in Japan and in Europe, and the ultimate result of the strike may be that American machinery and supply firms will lose a considerable amount of busi-



PHILIPPINE TYPHOONS have caused considerable damage to mining companies in the past few years. Large drainage ditches built near shafts and buildings provide protection from sudden onrushes of water. This drainage canal runs through the center of the mill of the Itogon Mining Company

ness, both now and in the future. The supply of fresh fruits and vegetables from the United States has been greatly reduced due to the strike.

✦ Gold production for the first ten months in 1936 totaled 25,450,291 pesos, while October saw the 4,000,000-peso mark passed for the second consecutive month.

✦ A serious slump in the mining stock market in Manila took place during the week ended Nov. 11. The Swan, Culbertson, and Fritz share price average dropped 74.47 points during Nov. 9, 10, and 11, and every issue on the boards of both the Manila and the International Stock Exchanges lost heavily. This stock slump was apparently caused by manipulation on the part of either brokers or speculators, since all news from the mining properties themselves had been unusually favorable. With the reelection of President Roosevelt, and a rise in the price of gold rumored from New York, there was reason to expect a boom market here. Conferences were held between brokers, mining leaders, and bankers, with the result that the slump was stopped, and the market recovered 44.88 points on Nov. 12.

✦ Two new projects have been announced by Marsman & Company. A 50-ton smelter is to be built near Manbulao, in the Paracale district, to treat flotation concentrates from San Mauricio and United Paracale. A new 10-cu.ft. bucket gold dredge has been ordered from the Bucyrus-Erie Company for Coco Grove. The smelter will be the first in the Philippines, and will eliminate the present expensive method of shipping concentrates to the Pacific Coast for treatment.

✦ The capacity of the Benguet Consolidated mill is being increased from 800 tons a day, to 1,000 tons. The new rate of production will be in effect within a few months.

✦ Base-metal mining in the Philippines has received stimulation by the organization of Amalgamated Minerals, an ore-buying organization, in Manila. Two English ore buyers, representing Anglo-Australian capital, are managing this concern, and have secured contracts for chromite, copper, and manganese ore. Several properties have been taken over for operation by Amalgamated Miners, and shipments of ore to Japan and to Europe will start soon.

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New Mexico

✦ The Chino copper mines, subsidiary of Kennecott Copper Corporation, at Santa Rita, started production on Jan. 1. The mines have been shut down since September, 1934, but equipment has been kept in working order and no delays were experienced in starting operations. R. B. Tempest, at Hurley, New Mex., is general manager.

California

Idaho-Maryland Begins Profit-Sharing Program

AMOUNT equal to dividends will be distributed among employees—More old mines reopened

✦ The Idaho-Maryland Mines Company announced recently a plan to share profits with its 600 employees, beginning this year. According to Albert Crase, general manager, the company will set aside funds equal to dividends paid on 150,000 shares, which would be distributed among employees on the basis of length of continuous employment. Payments to employees would be between $80 and $120 on profits equal to those of this year. This is thought to be the first such plan in the mining industry.

✦ Milling operations at the Eagle-Shawmut mine, at Chinese Camp, controlled by H. G. Miller and G. W. Clemson, president and vice-president respectively of Southwestern Engineering Company, Los Angeles, are now conducted on a 24-hour basis. The company has recently completed the first unit of a plant that will ultimately have a capacity of from 1,000 to 1,250 tons, and construction on the second unit is proceeding satisfactorily. Additional crushing, grinding, and flotation equipment is to be installed during the current expansion program.

✦ Natomas Company, Thomas McCormack, president and general manager, is reported to have purchased the Broder and Perazzo properties, in the Blue Ravine section of Folsom. Installation at a later date of a large dredge capable of digging 90 ft. below water is contemplated.

✦ Mother Lode Gold Mining Company has completed and placed in operation a new 100-ton flotation plant at the Mother Lode mine, near Drytown. Mining operations are carried on chiefly on the 300 level, where commercial ore has been developed recently. Early installation of an electric hoist at the shaft is planned. Operations are directed by W. Lucas, general manager.

✦ The Gold Company, Ltd., operating the Verrkamp mine, in Garden Valley, El Dorado County, has increased production to 175 tons by adding a 75-ton rod mill to the present plant. The mine is opened by a two-compartment shaft and a tunnel, and a substantial tonnage of commercial ore is said to have been blocked out. The mill contains amalgamation and flotation equipment. G. G. Chisholm is superintendent.

✦ Dredging operations have been started at Wallace, Calaveras County, by the Wallace Dredging Company, H. G. Peake, general manager. The 3-ft. dredge, operated on a 24-hour basis and employing two men on each shift, is removing about 1,800 yd. of gravel a day. A total of twelve men are employed under J. H. Payne, superintendent.

✦ Old mines reopened recently and under development include the Harvard mine, at Jamestown, controlled by Harvard Gold Mining; the Russell property, near the Black Oak mine, in Garden, by Producer Gold Mines Company, headed by R. M. Miller, president; and St. Joseph Lead Company is reported to have taken a 30-day option on the Sheep Ranch mine, an old gold producer, near Murphys, Calaveras County.

✦ Empire-Star Mines Company, Ltd., has completed cutting a station on the 9,400 level of the incline of North Star shaft, with sinking still in progress. Ore was encountered on the 9,400 level, the deepest mining in California, and indications are considered favorable for development of orebodies at greater depth.

✦ At the Norambagua mine, near Grass Valley, acquired recently by R. Potter Campbell, Inc., New York City, good progress is being made in rehabilitating the 1,250-ft. shaft, and two new plant buildings have been erected and the headframe has been repaired. A hoist and pumps are in course of erection. Marshall Draper is general manager.

✦ Power shovels, hydraulic equipment, and a screening plant are to be installed at the Cuddeback cinnabar mine, about 8 miles west of Tehachapi, purchased recently by Dan Murphy and associates, of Rosamond, Calif. Immediate resumption of activity is planned for the property, where a reduction plant containing a rotary furnace and a condenser system is available for treating mined ore. P. L. Blodget is in charge on construction work.

✦ Following unsatisfactory flotation and cyanide tests on its copper and iron sulphide ores containing precious metals, the Backbone Gold Mining Company, near Kennett, Shasta County, will smelt its ore in a 100-ton Mace smelter. Three 40-ton Mace hearths will be used for sintering fine ore, flue dust, and matte from the larger furnace. A 50-ton Mace furnace will be used in making a concentrated matte for shipment to a refinery. B. Brauston is president of the company.

HEADFRAME, MILL, AND DUMPS of the Pioneer gold mine, in Nye County, Nevada. This property, purchased by the General Milling Corporation, is to have greater cyanide mill capacity

Nevada

Copper Mines at Kimberly Again Producing

MINES in most districts increasing production

✦ The Consolidated Coppermines Corporation, at Kimberly, has started production, which soon is expected to reach 3,000 tons of ore per day. The mines have been shut down since May, 1932, and output will be handled under the old milling and smelting contract with Kennecott Copper Corporation, which expires in 1946. American Metal Company holds 10 per cent interest in Consolidated Coppermines. J. B. Haffner is general manager.

✦ Mining men of Nevada are deeply concerned over the proposal in Secretary Harold L. Ickes' annual report, recommending the withdrawal from location of all public mineral lands and establishment of a leasing system under which development of mineral deposits would be conducted under government supervision and permit. The suggestion has aroused a storm of protest from miners, prospectors, and claim owners, who declare such a system would put an end to all effort to discover and develop mineral deposits.

✦ Ore from new workings in the Central tunnel in the Ophir mine of the Consolidated Virginia Mining Company and from dumps at the portal is being trucked a mile and a half to the enlarged flotation mill of the Consolidated Chollar, Gould & Savage Mining Company, below Gold Hill, at the rate of nearly 400 tons per day. Zeb Kendall, president of the Consolidated Virginia, at Virginia City, said that November shipments had a gross value of $48,756. The mill operated 25 days, treating 9,745 tons of ore, with a recovery of $5 per ton. It is the purpose to ship 20,000 tons to ascertain the degree of efficacy of flotation on Ophir ore.

✦ Construction of a mill, probably of not less than 200 tons' capacity, and employing cyanidation, will be undertaken at the Nivloc gold-silver mine, in the old Stimler district, 8 miles west of Silver Peak, by Fred A. Vollmar, Jr., of Silver Peak. A 100-ton cyanide mill was completed a few months ago at the Mary mine of the Pittsburgh Silver Peak Mining Company. Mr. Vollmar, has given an option to E. L. Cord, automobile and airplane manufacturer, whose engineers are now in charge. Mr. Vollmar is acting in an advisory capacity. The Nivloc mine, opened to a depth of 840 ft. and with several thousand feet of lateral work, contains a substantial blocked tonnage of good mill ore.

✦ The capacity of a 10-stamp amalgamating and cyanide mill on the Pioneer mine, at Pioneer, southwestern Nye County, and 5 miles north of Rhyolite, is to be increased by the General Milling Corporation, which has purchased the property from J. R. Bryan and associates. The mine, with a 900-ft. shaft and about 15,000 ft. of workings, produced something over $500,000 in gold prior to 1925, when controlled by the late W. J. Tobin. A lease north of the main shaft made small production when the property was operated by Tex Rickard, then, with two partners, running his famed Northern saloon and gambling house in Goldfield. The Pioneer was the most productive mine in the district. General Milling Corporation, composed of New Jersey men, has been operating several old mines acquired within the year, including the Bullfrog Homestake, National Bank, Denver, and Senator Stewart mines and the Tramps Consolidated mill. F. E. Nemic, of Beatty, is manager.

✦ Enlargement of its 50-ton cyanide mill and further development of unexplored areas are planned at the Buckskin National gold-silver mine, in northern Humboldt County, by the Nevada Lucky Tiger Mining Company, a subsidiary of the Lucky Tiger-Combination Gold Mining Company, which is operating under lease providing for equal division of net proceeds with the owner, Buckskin National Mining Company.

✦ Engineers reputed to be acting for the John J. Raskob group have been inspecting and sampling gold claims in the old Central district, in northern Pershing County. An old 250-ft. incline shaft on the Marietta claim is said to have produced shipments of high-grade smelting ore and recent surface work has exposed several wide quartz veins, yielding gold.

✦ A large part of the Garfield mine, in Mineral County, once the largest silver producer in Nevada, and with output of over $6,000,000, has been acquired under lease by the W. M. Mining & Milling Company from the owners, J. H. Miller, of Hawthorne, and W. J. Harris, of Reno. The W. M. Company has been operating the old Kernick mill, at Sodaville, as a custom plant and late in the year obtained a lease on old mine dumps at the Garfield, later leasing the eastern part of the property. It is now the purpose to provide a mill of a least 100 tons' capacity and to reopen old workings. F. P. Merry, of Mina, is manager.

✦ Nine buildings have been completed and foundations are being prepared for construction of a 40-ton cyanide mill at the Nevada Hills mine, in the Fairview district, Churchill County. The mine, which produced around $3,000,000 in gold and silver prior to 1917, is now owned by the Nevada Range Mines, Inc. E. P. Jennings, of Fallon, is manager.

✦ Men who are said to be in the employ of interests operating at Austin, Lander County, have been sampling the Simon Silver-Lead mine, 20 miles east of Mina, Mineral County, and the Warrior gold-silver property, 5 miles east of the Simon.

✦ Mountain City Copper Company paid its first dividend on Dec. 24, amounting

to 21c. a share. This follows closely on the putting into operation, in September, of the new flotation plant at the property, situated at Mountain City, Elko County. At present, the company is daily shipping 200 tons of ore, averaging about 25 per cent copper, and 100 tons of concentrate, carrying about the same metal content. About 300 tons of 10 per cent copper is being fed into the mill daily. Sinking of the No. 2 shaft from the 500- to the 800-ft. level has begun in order to attain depth on the orebody. All of the present production of the mine is coming from above the 400 and most of it above the 300. Production of the mine is said to be running between 3,500,000 and 4,000,000 lb. of copper each month, at a profit of about 4c. a pound. Earnings are reported to hold, at this rate of production, around $480,000 a quarter, or 20c. a share.

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Calumet & Hecla Gives Bonus

✦Approximately 2,400 men are now employed by the mines of the Michigan copper district. With wage increases now in effect the rate of pay ranges from $3.15 to $7.00 per day, the latter on contract. Men underground are privileged to increase their particular rate by exceeding the minimum production requirements. Calumet & Hecla Consolidated has paid two bonuses to its men, each for $12.50, one on Oct. 1 and one on Dec. 15. Each bonus was equivalent to a dividend of 25c. per share on 50 shares of stock.

✦Work of putting the property of the Quincy Mining Company, including the mine, mill, and railroad, in condition for resumption of operations after a period of idleness of more than five years, is progressing rapidly. Approximately 100 men are now employed. At the mine, the first of the big pumping units has been started. Considerable dewatering will have to be done before extensive underground operations are possible. Progress to date is considered very satisfactory.

✦The Norgan Mining Company, which had a crew of geologists at work in the gold district near Ishpeming, Mich., has suspended operations until spring. A diamond drill operated there by the E. J. Longyear Company has been removed from the property, but will be returned when work is resumed. The Norgan Company has made no announcement concerning the results of the work to date. It is understood that the property is to be thoroughly investigated.

Colorado

Smuggler Union Mine Taken Over by New Company

EXTENSIVE underground development planned—A.S.&R. mill at Alice completed

✦The historic Smuggler Union mine, at Telluride, which has produced ore valued at $65,000,000 during the past 60 years, has been taken over by Veta Mines, Inc. The property has been owned and operated during the past few years by the Telluride Holding Company, of which Ben Grimes is president. The mine is considered one of the largest in the West and has about 50 miles of underground workings. Robert H. Sayre, Denver mining engineer, heads the new Veta Mines Company and Charles Glasgow is superintendent, E. Coperthwaite is mine foreman, and John Ferguson, mill superintendent. The new company plans extensive mine development and will increase the mill capacity to 400 tons daily.

✦A. F. Woodward, general manager of Kolman & Company, has started reopening the El Paso Nichols shaft, at Cripple Creek. The company intends to erect a new headframe, install a 100-hp. hoist and compressor, and construct surface buildings. Complete equipment for ten leasers will be installed.

✦The sump from the 950-ft. level of the Cameron Mines Company has been completed, and lateral drifting started on that level. Ore is mined from the upper levels and shipped to the mill. H. Peiffer is in charge of this work.

✦Leadville and Cripple Creek mine operators met recently in Colorado Springs with Government officials and United States Senator Adams, from Colorado, and discussed proposals for drainage tunnels in Leadville and Cripple Creek. Cost data for driving these tunnels, and the possible return, were presented by engineers from the two mining districts. No definite action was taken other than to seek aid from Congress in supporting the undertaking financially. Driving of these two tunnels would permit development of orebodies known to exist below the present drainage tunnels.

✦Robert E. Lowther, of Buffalo, N. Y., and W. T. Watson, of Cripple Creek, have purchased the Prince Albert acreage on Beacon Hill. Considerable work has been done on this property during the past three years. The main shaft is 500 ft. deep and lateral development is extensive. A 100-ton concentrating plant is planned.

✦C. E. Joslin, superintendent of the Logan Mines of the International Gold Producers Company, has been producing over 100 tons daily during the past year, and the company's balance sheet shows a net profit from these operations for the year. The ore is treated at the New Cripple Creek Milling Company's mill.

✦Work on opening the orebodies on the eighteenth level of the Cresson, at Cripple Creek, is progressing rapidly, employing two shifts. It is expected the veins will be cut around the first of the year. Water flow necessitates pumping at a rate of 2,500 g.p.m. Alfred Bebee is general superintendent.

✦The American Smelting & Refining Company has completed its 200-ton mill at Alice. Mining operations here during the next few years are generally considered a development of major proportions. Arthur Johnson is general superintendent, E. L. Benson, mine superintendent, and Charles W. Dahlberg, mill superintendent.

✦The Minnesota Mines Company, at Empire, has completed enlarging its mill, to 250 tons' capacity. D. A. O'Dell is general manager; P. H. Bertchy, mill foreman; and G. R. Messick, mine foreman. The company has completed sinking its 360-ft. shaft, and is now drifting on the vein.

✦Receipts at the Leadville smelter of the American Smelting & Refining Company show a 20 per cent increase for the year of 1936 over the record for 1935. At present two furnaces are operating.

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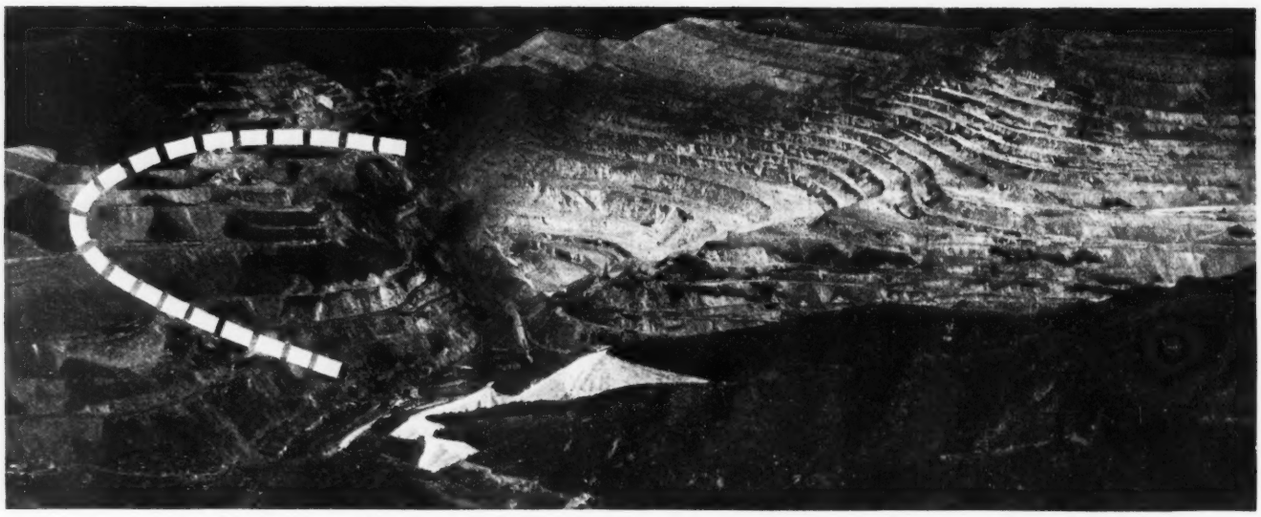
Washington

✦The Federal Power Commission has approved the application filed on Sept. 11, 1936, by the Pend Oreille Mines & Metals Company, of Spokane, and granted a license for construction of a hydro-electric project on Clark Fork of the Columbia River at Metaline Falls, in Pend Oreille County. The project will consist of an intake above the falls, a tunnel about 600 ft. long, a power house below the falls with installed capacity of approximately 2,000 hp., and a 3,000-ft. transmission line. President Lewis C. Larsen expects that costs of mining and milling will be materially lowered when the electrical energy is provided. Mill capacity is now being increased and mine production will also be increased ready for the larger mill by May 1.



APPROXIMATE LOCATION of the long tunnel planned at Utah Copper. It will permit traffic between Copperfield (in the background) and Bingham Canyon while mining operations are carried out adjacent to the present highway which follows the canyon

Utah

Vehicular Tunnel Project At Utah Copper

WILL PERMIT TRAFFIC between Copperfield and Bingham Canyon—Labor strike settled

✦ Plans are being made by the Utah Copper Company for a huge engineering project that will have many ramifications new to the Utah mining industry and will require about a year to complete. A million-dollar concrete-lined tunnel, wide enough for two traffic lanes and a foot path for pedestrians, will be bored through West Mountain to link Bingham with Copperfield, over a mile up the canyon and now connected by a highway, to be abandoned. News of this project came officially to the public on Dec. 18, when an agreement was effected between Salt Lake County and Utah Copper Company removing practically all legal obstacles relative to rights-of-way, operation, and maintenance costs. Some final arrangements remain to be completed before preliminary work is started, but little delay is expected. The purpose of the tunnel will be to allow mining of ores lying adjacent to the present highway without interfering with traffic between the upper and lower parts of Bingham. The lower or north portal will be situated on the east side of Main St. in Bingham, a short distance above Carr Fork junction. The length of the tunnel will be 6,998.5 ft.; the width between sidewalls, 16 ft. 4 in.; height, 10 ft.; grade, 6.44 ft.; course of the bore, southeasterly. Space for pedestrians will be provided by a foot path 2 ft. 8 in. above the traffic lane. The company on its own responsibility retains the right to install within the bore, and to maintain, air lines, fresh-water lines, copper solution lines, and electric feeder lines. It will install for public use an 8-in. sewer pipe. The expense of maintaining the tunnel will be borne by the company. Costs of damages caused by earthquake, blasting, swelling of the earth, slipping of faults or any earth disturbance will also be met by the company. During a two years' test period, a check will be made on lighting, ventilation, and traffic control. If the county deems the facilities insufficient, the Utah Copper Company binds itself to replace or supplement such equipment in conformity with the county's recommendations. In case the mining company's operations in the territory adjacent make it imperative to abandon the tunnel, the company also agrees to build at its own expense a surface highway around the perimeter of the mine pit that will conform with the county's requirements.

✦ Concentrated and untiring effort on the part of Governor Henry H. Blood brought to an end on Dec. 16 the labor strike of members of the International Union of Mine, Mill and Smelter Workers at Park City. The 67-day strike, however, ended only after striking miners in Park City and residents of Heber Valley, seeking work in the mines, had fought a pitched battle in the streets. Tension reached a high level following the battle with fists and stones. No one was seriously injured, but the invading miners were beaten back. Two days after the vote to end the strike at Park City, a similar action of silver-lead miners at Bingham and Lark terminated the strike in this area also. The men voted to accept terms guaranteeing them a 25c. a day increase in wages and no discrimination against members of the union. Former employees of the mines were accepted first, and operators bound themselves not to impose medical examinations for the purpose of excluding strikers. Activities of both camps have been resumed on a normal scale.

✦ The Cardiff Mining & Milling Company, according to an announcement by Lynn H. Thompson, president, has leased until June 1, to Nick Kolovis and Associates, its property in the South Fork of Big Cottonwood Canyon. In addition to mining on levels from the 700 down to the 1,400, the lessees agree to keep the lower levels unwatered and prospect the downward extension of the Cardiff fissure.

✦ Ore of increased values in silver and lead is being taken out of the Utah Ophir mine, 10 miles southeast of Stockton, according to J. F. Featherstone, president. Lessees are following a fissure about 170 ft. from the portal. A carload of ore was shipped recently.

✦ Operation of a new mill has been started at the West Dip mine, operated by Mark L. Requa, of California, in the Mercur district. L. K. Requa is in charge of operations. The mill is of the all-sliming, counter-current decantation, cyanide type. Water is brought from Ophir Creek, a distance of 4 miles. The power line, carrying 11,000 volts, has also been built from the same locality. C. E. Bartlett is mill foreman and J. E. Young, mine foreman.

✦ Sinking of the Frisco Silver Lead Mining Company's shaft, near Frisco, Beaver County, has reached the 300 level, where a body of high-grade silver-lead ore has been entered, according to the manager, F. L. Block. On the 200 level the company has opened an orebody running from 6 in. to 20 ft. wide and having a length of about 230 ft., it is reported. Ten carloads of ore, ranging from $1,000 to $1,200 net, have been shipped.

NEWS FROM WASHINGTON

By Special Correspondent

LABOR QUESTIONS affecting mining are dominant in Washington. Strikes are numerous, and may become more so. Legislation of many kinds is being drafted or pressed for enactment. Every phase of employment is receiving attention. There is a fundamental difference in all this now as compared with the situation even one year ago. Then reemployment and relief were dominant problems. Now reform and regulation of industry are given preferred place, though reemployment refuses to be eliminated.

Enactments by Congress will probably be much less drastic than many of the radical proposals offered. This is always true. The wise legislator in his first bill asks for more than he expects or even wants. Thus he leaves plenty of trading area in which to retreat without sacrificing a fundamental desire.

Labor Laws

The National Labor Relations Act is a keystone of the labor arch in the present administrative structure. An ultimate disposal by the Supreme Court of the constitutional questions inherent in the administration of that act is therefore of greatest importance for mining executives. Should the Court declare that the principles on which N.L.R.B. is proceeding are unconstitutional, the whole present structure will fall. No one knows what can then be done, nor even what the Administration would attempt to do. But the confusion following such decision would be much greater than that succeeding the demise of the Blue Eagle.

Labor leaders are very powerful in Washington. The breach between the A. F. of L. and C.I.O., definitely confirmed by the recent Florida convention of the Federation, somewhat hurts the influence of both groups. But there is no fundamental division in purpose at Washington. The battle over technique of organization will not interfere with cooperation, very real though not conspicuous, when a labor law is in the making. The fact that C.I.O. is now housed in the new home of United Mine Workers (the old University Club!) does not really remove them in spirit from Federation headquarters.

Before the next Congress there will be at least a half dozen important, vigorously pressed items of legislation. Some will be well-known veterans of past Congresses unenacted but still very much alive. Others will be new. The following general efforts will deserve notice on the part of mine executives:

1. A 30-hour week bill. Enactment is highly improbable as such, but furnishes splendid trading basis.

Rising Prices

● Commodity price rises were unquestionably restrained in pre-election days. Hence the inevitable up-trend of the recovery months is now accentuated. All this worries official Washington, though not so much as it would have done pre November. Speculation is blamed. Some restraint on speculation will be attempted. The Federal Reserve Board will use both its authority to require higher bank reserves and its privilege of open-market selling of Government bonds. Economists hope, and rather expect, that these actions will increase the cost of money and reduce funds available for speculative market operations in securities, raw materials, and merchandise.

Those seeking refinancing of industry should take note, and perhaps act promptly before money rates do go up. Those interested in maintaining present market prices of commodities will have other factors to consider, but should not neglect these. With respect to export commodities, too much emphasis should not be placed in forecasting on advance temporary buying for munition reserves, so Washington says, as it disagrees with certain market operators.

2. The Federal incorporation bill (O'Mahoney), veteran of many Congresses, now directly backed by A. F. of L. When labor backs this bill, Washington knows that its proponents are unable to devise a better, more direct, way to attack the stronghold which they wish to occupy. This time it may pass, but labor wou'd much prefer a direct bill, such as—

3. Minimum-wage and maximum-hour standards defined by Congress. These may take a general form or be proposed for a single industry, à la Guffey bill for coal.

4. A tightening of the Walsh-Healy Act to give wider application on sales to the Government. Difficulties in buying copper do not discourage the proponents of this indirect plan of labor-standards fixing.

5. Bills to emphasize the importance of unionization, supplementing and strengthening the present N.L.R.B. This effort probably has strongest support of the President.

6. More emphasis on social security. A. F. of L. will ask that all payroll taxes be put on the employer, but will probably not get this favor this year. Watch out for it next Presidential campaign year!

7. Further aggressive study of anti-strike methods. The La Follette committee will probably get money to prosecute its investigations of guns and gas. There may even be drastic follow-up in legislative proposals. Some people, very clever in molding public opinion and influencing legislation, are behind this project. It probably has in it more of direct concern to the mining industry than any of the other proposals, should it be successfully pressed.

One pro-employer item may be cited. If the nation does not get a Christmas present or a New Year's greeting in the way of a permanent solution of the shipping strike (which may come between the writing of this and the reading), that situation can develop labor-control possibilities. Out of it some optimists, probably over-hopeful, have hoped that there could be established legislation making labor unions and like bodies financially responsible for their acts, just as corporations now are under the law.

Anti-trust Policy

A dozen new proposals on anti-trust legislation are intended to clarify, but actually do confuse, this important business issue. The proposals range all the way from outright repeal to rigid enforcement of the anti-monopoly laws. And some would even make the present laws more detailed, more rigid, more complex. Assistant Attorney General John Dickenson perhaps gives the most illuminating and significant comment. This he presented as an unexpected part in the recent Berry conference. On that occasion he explained that probably business men were not as much afraid of anti-trust enforcement as they might be because the Department of Justice has about enough money to bring two good suits a year. This statement was obviously not intended to encourage the philosophy of taking a chance by business men. It had two quite different motives. First it was a defense of his own division's

"neglect" of many cases proposed. Second, and more important, it was a springboard from which to jump into proposed revisions of the law.

Most useful in planning future policy are the ideas reliably credited to Donald Richberg, who in mid-December was made a free lance by acceptance of his resignation from a post in the Department of Justice, where he had been serving *incognito*. Richberg apparently believes the only way either anti-trust or labor-control legislation can be made to stick in the courts will be by entirely new philosophy. He would have these standards fixed by voluntary agreement within each industry under rules to be laid down rigidly by Congress.

The interweaving of anti-trust effort with labor-control measures seems definitely a probability in the next Congress. But forecasting of legislative results at this stage is obviously futile.

Mines Bureau Money

More money for both economic and technologic research of the Bureau of Mines would be welcomed by its officials. This is nothing new. But there is a new problem of adjustment between wanted economic and proposed technologic expansion.

Economy is not pressing too hard on budget plans thus far. But expansion on any great scale is not expected. Hence Congress will have to decide whether it wants more scientific research or additional economic investigations, or both. It will probably not be both in the present temper of the White House and the appropriations committees.

Representative Scrugham, chairman of the House committee on appropriations, would like to see the technologic work increased, particularly that which would be done in Nevada. In the last Congress he was disposed to take away enough of the economics appropriation to establish the new Boulder Dam station of the Bureau. The Senate agreed to the new station which he wanted, but restored the funds for economic studies.

Definite Congressional support seems assured for those electrometallurgical investigations that suggest possible new industries utilizing power and Western natural resources. Notable among the investigations are those previously described in *E. & M. J.*: Electrolytic manganese, carbon-free metallic chromium, antimony, and other products of cheap power.

Washington recognizes that support of an interested mining industry will be essential if the corresponding economic studies are to be supported. Outstanding among these are: World mine and mineral survey; periodic survey of scrap-metal supply and use, not alone iron and steel, on which a start was made last year; more complete annual reviews of mineral statistics; and periodic forecasting of demand for copper, lead, zinc, and other metals; proposals for these and other economic studies have been made and are being considered by Bureau officials and by the Advisory Board of the Bureau. Mineral economists in official life hope that next year will see a number of these projects definitely supported by regular Congressional appropriations.

No Copper for Navy

● Copper producers "do not choose" to bid on Navy requests for needed copper under the uncertain provisions of the Walsh-Healy Act. At least this was the situation on two occasions in December when bids were opened for about two million pounds of the red metal; and there were no bids to open. Other departments are reported to be having the same difficulty, which is occasioned altogether by the Walsh-Healy law governing labor conditions in works of companies selling to Uncle Sam.

All sorts of big words are being carelessly used about this case, such as "collusion," "boycott," "retaliation," etc. The way out for the Navy is comparatively simple under the law. With the aid of the Department of Labor it can negotiate a purchase in the open market which would be exempt from the Walsh-Healy Act. This would supply the Navy and other departments, but would not lay the dust cloud which has been kicked up.

The matter is far more serious in this case because the Navy is the President's "pet." Nothing must interfere with its well-being, which is probably fortunate. But there is grave danger that not only copper producers but others will be regarded very harshly at the White House because of their unwillingness to go along under the new law.

This instance may well provide the test case on which ultimate determination is made of the reasonableness of indirect regulation of wages and hours under the guise of government contract policy.

Berry Conference

Cooperation for reemployment and better industrial relations was the objective of the Berry conference held during December. Although attended by a large number more representative of American business than many expected, the atmosphere was one of skepticism. Refusal further to cooperate was conspicuous, by a large section of the industrial groups not attending. About 700 persons indicated their intention to affiliate with the movement by signing up as members of the Council for Industrial Progress.

Committee reports were presented on various phases of anti-trust legislation, national industrial policy, maximum work week, wages, and child labor, fair trade practices, internal and external competition, Government competition with private business, financial aid to small enterprises, and employment data.

A correlating committee was named to systematize the overlapping recommendations of these committees and the recommendations of the Council. A legal committee will draft such new legislation as seems advisable for submission to the President. Coordinator Berry has expressed the hope that the correlating committee will be able to draw up recommendations for improving Federal influence on employment within constitutional limits. If this fails, he will back an amendment to the Constitution.

Pressure Groups

In a democracy the majority rules. That is good theory. But the realist knows that a minority closely knit and vigorously led can get many of its desires fulfilled promptly. This will be particularly true in this session of Congress despite the unprecedented majorities which will acknowledge New Deal leadership.

There is both comfort and threat for the mining industry in the magnitude of these majorities. They will be so big as to insure prompt enactment of any bill which is positively an Administration measure. But the very magnitude of the majority makes it somewhat unwieldy. Special pressure groups will spall off; each will log-roll for its favored bill. Combinations of blocs will, therefore, be potent. And, unfortunately, by means of the trading of votes between blocs, certain highly objectionable measures are likely to pass. Even a sincere majority is not always adequate to prevent this. Witness silver!

For several years past a bloc of Western Senators, 24 in number, have held veto power over the President with respect to many measures. They have demanded that their favored commodity be given attention before other bills, having no relation to the precious metals, could pass. The mining industry will very much wish to know whether that bloc, now numerically less important in view of the huge Democratic majority in the Senate, can or will even attempt this domination. Washington speculates but dares not forecast on such points. And the silver bloc is not the only one that the mining industry must watch for good or for detrimental effects.

Arizona

Copper Mines at Ray and Hayden Smelter to Reopen

PLANT CLOSED during last six years—Small mining operations increase in number

✦ The Hayden copper smelter of the American Smelting & Refining Company, at Hayden, is planning to open March 1, 1937, according to an announcement made by Superintendent H. F. Easter. The plant closed down on Jan. 31, 1931. About 70 men are now employed and an additional number will be employed when smelting operations are resumed. The plant has an annual capacity of 550,000 tons of ore and concentrate, and is equipped with three reverberatories and three converters.

✦ The copper mines at Ray, owned by the Kennecott Copper Corporation, went into production around the first of the year. They had been closed since April, 1933. B. W. Thomas is general manager.

✦ Chloride Reduction Company, at Chloride, Mohave County, is being delayed in starting operations by the nonarrival of the flotation cells. As soon as these arrive and are installed the mill will be ready to start on custom ores.

✦ The Tennessee-Schuykill mine and mill, at Chloride, Mohave County, are operating steadily. They are making an excellent zinc and lead separation and are shipping a carload of concentrates every third day. R. L. D'Arcy, formerly with the United Verde company, is in charge of the mine. Jacob Shoder, formerly with the Sunshine Mining Company, near Wallace, Idaho, is mill superintendent.

✦ Pioneer Gold Mining Company, operating the Pilgrim mine, northwest of Chloride, recently developed a shoot of high-grade ore in a feeder vein. Drifting on the new strike has opened up ore over a good distance. It was first struck on the 300-ft. level and above and later found on the 500-ft. level. Earl Hastings is manager of the company and M. C. Richardson mine superintendent.

✦ The Gold Standard mill, at Katherine, Mohave County, is now milling approximately 250 tons daily. The ore comes from the Portland, Philadelphia, Arabian, Minne, and Sheeptrail properties, all owned or controlled by the company. Richard de Smet is manager and vice-president of the company.

✦ Bi-Metal mine, 3 miles southwest of Kingman, Mohave County, is milling 100 tons of ore daily. The mine is an open-pit operation and the ore is loaded by power shovel into trucks for a short haul to the mill. The property is a shear zone enrichment and three years of ore reserves are available for mining. S. S. Jones, Claude Wilkinson, and S. Weeks are owners and operators.

✦ Diamond drilling from the 500-ft. level of the Sulphuret mine, near Tombstone, is under way. The mine was recently opened by the Eagle-Picher Lead Company.

✦ A 50-ton mill to treat vanadium ores is being erected near the old Escapule workings, in the Dragoon Mountains northeast of Tombstone. Water for the mill will be pumped from a well on the site.

✦ John Chiono and associates have bonded and leased the Lost Treasure mine, 21 miles southwest of Wickensburg, and are reported to have developed some good ore. Shipments are expected to be made soon. Mr. Chiono's address is Wickenburg, Ariz.

✦ DeMund Brothers have installed mining and milling machinery on their Gold Standard mine, 35 miles northwest of Congress Junction. The plant consists of an Allison steel 30-ton ball mill, Dorr classifiers, an alloy steel rock crusher, Fairbanks-Morse engines, and Gardner-Denver compressors. Water is obtained from the Santa Maria River. Jack Dryden is mine superintendent and Ray Pass is assayer and in charge of the mill. Charles DeMund, president of the Arizona Hardware Supply Company, is president and general manager.

✦ Venture Mining Company, in the Patagonia district, Santa Cruz County, expects to increase ore shipments in the near future. Hugo Miller is superintendent.

✦ The old Reef mine, in the Huachuca Mountains, is producing tungsten ore which is being hauled by truck to the shipping point. J. J. Sleeman is in charge.

✦ Johnson Gold Mines, Inc., at Octave, are reported to be shipping exceedingly high-grade concentrates. T. A. Barkley is superintendent of the company.

Tri-State

Mines Prepare for Higher Zinc Output

DEWATERING PROGRAMS under way in several areas

✦ Completion of the dewatering of the Oronogo district, in the old Missouri section of the Tri-State district, has been decided upon by the Eagle-Picher Mining & Smelting Company of which George W. Potter, of Joplin, is vice-president. Eagle-Picher took over the dewatering operations in that section of the district that was started by Frank Childress and associates and completed the dewatering of the Oronogo bottoms and the North Webb City field at a cost of more than $200,000. The north end of the Oronogo field did not react to these pumping operations, however. The company will install a small Pomona turbine pump on the La Tosca, under lease to Frank Fenix, of Joplin, former Missouri State Mine Inspector. La Tosca's fee belongs to the American Zinc, Lead & Smelting Company, G. W. Johnson, Joplin, manager. Oronogo Mutual Mining Company, W. Guy Waring, of Oronogo, manager, is mining on the deeper level on the La Tosca, and Fenix has mining rights down to the 145-ft. level. The water on the upper level of the La Tosca now stands at about 115 ft. It is expected that it will take two or three weeks to dewater the upper ground. The dewatering of the upper levels is expected to take the head water off the Oronogo Mutual's underground workings.

✦ The Lead & Zinc Producers, Inc., under the direction of R. T. Hartley, Joplin, has installed a five-stage, 10-in. Texas pump on the Taylor-Glover land, in the Chitwood district, west of Joplin. The land will be dewatered to the 160-ft. level eventually. An Erie boiler has been installed and a 600-ft. compressor is being installed at the shaft. The equipment will allow for the immediate working of the ground as soon as the water is eliminated.

✦ Joe Nolan, of Picher, Okla., has obtained a lease on the Cherokee lease of the Interstate Zinc & Lead Company's lease, near Treece, Kan., from C. F. Dike, manager. A 2-in. pump has been installed to dewater the tract. The ore from the lease will be trucked to the Woodchuck mill of the Interstate for treatment.

Montana

New Mills Begin Operations

ANACONDA COPPER diamond drilling in German Gulch

✦ During November, the 100-ton cyanide mill recently completed by E. L. Sweeney, of Denver, started operating at the Ermont mine, near Dillon, Beaverhead County. R. B. Caswell, of Dillon, is manager. The company controls 34 claims in the district, in which the characteristic gold occurrences are in andesite near limestone contacts. Production will be maintained from open-pit as well as underground workings.

✦ Anaconda Copper Mining Company is reported to be conducting an extensive diamond-drill program at the Beal property in German Gulch, Deer Lodge County. This property has long been credited as the probable source of the placer gold recovered from German Gulch, the gross value being reported at $12,000,000.

✦ Retroactive to Nov. 1, 1936, salaried employees of the Anaconda company were reestablished upon full base pay rate. Prior to the announcement late in November by W. B. Daly, general manager of mines, the rate had been upon a 90 per cent basis.

✦ The experimental work of Anaconda in the field of deep mine ventilation and air conditioning is of great interest to the mining industry, since depth developments in many of the districts are being extended at alarming rates. The deep mine ventilation problem at Butte had been anticipated for some time by researches into the accepted methods of regulation, and it is interesting to note that the recently completed installation of a full-scale air-conditioning plant at the Mount Consolidated Mine departs widely from the principles employed in other mine air-conditioning plants now in use throughout the world. A. S. Richardson, ventilation engineer for Anaconda, has done considerable pioneering in developing this type of mine air conditioning. Similarly, the broad-minded view taken by the management of the company in supporting these investigations, particularly in so far as they digressed from the limits of known practice, is creditable. At a recent meeting of the Montana Section of the A.I.M.E., Mr. Richardson outlined the methods and equipment used in the Mount Consolidated air-conditioning plant at Butte, which was installed in August, 1936, on the 3,500 level. The primary objective of the plant, according to Mr. Richardson, is to condition a large volume of air at low cost. The principles of the system adopted consist of interchange of heat from the mine air treated to a brine solution in closed circuit, from which latter the heat is dissipated in a cooling tower at the surface. Mr. Richardson described the system in terms of units: (1) the cooling tower; (2) the brine circuit, and (3) the underground heat interchanger. Many ingenious features are in successful operation in the Mount Consolidated plant.

✦ Construction of a 130-ton flotation plant at the Atlantic and Pacific mine, near Pony, Madison County, by the Montana Southern Mines Company, was completed early in December. The mill was built by M. I. Leydig, who will continue in charge of operations. The operation will be serviced by electricity from the Montana Power Company through transmission lines connected to the old lines between the Mammoth and Boss Tweed mines. Immediate production will be from open-pit work in which power shovels will be employed.

✦ Among the more important exploratory programs currently reported to be in progress is the comprehensive campaign now being conducted at the Golden Sunlight mine, near Whitehall, in Jefferson County. Wade V. Lewis is in charge of a crew of 40 men at the property, in which it is reported the A. O. Smith Company, of Milwaukee, is interested. The property is generally thought to constitute an important potential large tonnage, low-grade gold resource.

✦ Virgil M. Price, of Long Beach, Calif., and associates have acquired an option upon the Gold Hill group of claims in the Princeton district, near Philipsburg, Granite County. According to the terms of the agreement, it is expected that an extensive development program at the property will be started in the near future.

Idaho

Miners Seek Faulted Orebody

OPERATORS hope to find continuation of Minnie Moore vein

✦ Western mining men are interested in the operations at the famous old Minnie Moore property, in the Wood River district, near Hailey. W. J. Stratton and associates, of Spokane, are making an effort to find the faulted orebody, in ground adjacent to the former holdings of the Minnie Moore company. A crosscut is now about halfway to its objective, seeking to find the Minnie Moore vein below the fault on the 1,000-ft. level.

✦ The management of the Silver Bar Mining Company, operating in the Beaver Creek district, has let a contract to drive 280 ft. of crosscut in the main tunnel. The new work is planned to cut two veins at a depth of approximately 400 ft. Manager Ray Kleppinger, of Wallace, reports that the company recently installed new ventilation equipment.

✦ Assays of ore from the claims of the Elk City Gold Mines, Inc., show a gold content ranging from $100 to $600 per ton, it was reported from Lewiston by A. J. Warren, an official of the company.

✦ A Christmas bonus of 3 per cent of their annual earnings was paid to all employees of the Sunshine Mining Company. The average payment to men who had worked throughout the year was $50.

✦ A drift on the 800-ft. level on a promising silver-lead vein in the Bunker Chance Mining Company's property, in the Wardner district, is well under way. Three veins have been found south of the Alhambra fault and a drift is now being extended along the No. 1 ledge, which is about 20 ft. wide. A three-drill compressor, a larger power unit, and other equipment were recently installed. Nick Petrinovich, of Wardner, is president of the company.

✦ Arrangements are being made for the installation of a 50-ton mill at the Washington Subrosa mine, near Idaho City, by the Consolidated Mines Syndicate.

✦ Plans for the erection of a mill at the Gibbonsville Mining and Exploration

Annual Meeting of The American Mining Congress Convenes Jan. 26

● The regular annual meeting of members of the American Mining Congress will be held on Tuesday, Jan. 26, at 2:30 p.m., in Assembly Room 4 P of the Waldorf-Astoria Hotel, New York City. Four directors are to be elected for a three-year term, to succeed the following members, whose terms expire: A. E. Bendelari, A. B. Jessup, D. D. Moffat, and C. H. Segerstrom. The meeting will be a business session, without any formal program, and will be devoted to a general discussion of the policies and work of the American Mining Congress.

Company's property, 14 miles north of Salmon City, are being considered. The ore is scattered over a wide area in boulders in the wash gravel. Engineers estimate about 100,000 tons are available for treatment which can be mined by a power shovel. The ore is said to assay about $4.50 to the ton in gold, silver, and lead. Offices of the company are in Kellogg, with M. M. Eaton as secretary.

Iron Country

Iron Ore Increase This Year

✦ All ore shipping was discontinued about the first of December, a few boats taking chances on the last minute allowed by the Federal authorities, but very little iron ore was moved in December. The ore movement to December 1st shows 44,822,023 tons, compared with the total season of 1935 at 28,362,368 tons.

✦ Stripping operations were carried on until around the first of the year at several of the open pits, as the iron-mining industry generally believes iron ore shipments will be about 10,000,000 tons greater in 1937 than in 1936. Some preliminary work is being done at the Hill-Trumbull mine of the Mesaba-Cliffs Mining Company at Marble, Minn. This is the first time any work has been done at this property since 1931. It is hoped that this mine will be in production next summer. H. C. Bolthouse is in charge of the Hill-Trumbull mine.

✦ An estimate of the number of men employed in the iron-ore mining industry in Minnesota during the past summer would be approximately 10,000 divided as follows: Cuyuna Range, 500; Vermilion Range, 1,800; Mesabi Range, 7,700.

✦ The Minnesota Supreme Court recently upheld a decision of a lower court that twenty companies must pay $7,500,000 in back taxes which had been withheld pending the decision. The mining companies include fifteen subsidiaries of the United States Steel Corporation, which contended that the assessed valuation of $88,000,000 set by a District Court decision was too high, whereas the State contended they were too low. The court approved the Lake Erie "pegged" price as the basis for valuation. This is established from the first ore sale in each shipping season. This method has been accepted as a standard for many years.

✦ The Republic Steel Corporation has surrendered the lease of the Schley mine, at Gilbert, Minn. The lease was held for a number of years.

Mexico

Settlement Comes to Major Labor Strikes

WAGE INCREASES and other demands are worked out between workers and employers

✦ Winter's advent found less tension in the Mexican mining industry, with settlement of the strike at Asarco's Morales unit, San Luis Potosi, several months long, that had brought talk of a general mining shutdown. Several companies soothed labor by raising pay. Some increased wages on the strength of improved markets. More official aid was given miners' cooperative societies and there was a fair amount of development in several regions.

✦ Settlement of the Morales strike on Dec. 5 was on the basis of an agreement whereby Asarco allowed the workers 70 per cent of wages during the shutdown, a settlement that cost 320,000 pesos (about $87,500), 10,000 pesos as cost of the strike, a general wage increase of 20 per cent, minimum daily salary of 2.70 pesos (the former minimum was two pesos), free medical services and medicines for all employees and their families, and paid vacations. The company's Matehuala unit, also in San Luis Potosi, which was obliged to close, resumed operations with settlement at Morales. Asarco paid its 800 Matehuala workers full wages during the idle period of that unit. Ending this strike also enabled some other mining units to resume work.

✦ Daily production of 28 tons of ore containing a half ounce of gold and 1½ oz. silver per ton is being maintained by Cia. Minera del Picacho, Sonora, from the company's 30-ton cyanidation plant. Walter Douglas is president, Henry Bollweg, Jr., of Douglas, Ariz., is manager, and H. H. Horton, of Nacozari, Sonora, is secretary of the company.

✦ The Federal Supreme Court upheld action of the Ministry of National Economy in canceling the concession of Sulphur Mines & Railway to exploit a sulphur deposit in San Luis Potosi, on the ground that the company did not start operations within the period specified by the franchise. The deposit has been placed at the disposal of workers to operate on a cooperative basis.

✦ San Luis Mining Company settled labor troubles at its Tayoltita and Socavon units, Durango, by increasing miners' wages to from 3.60 to 4 pesos daily and allowing other employees a pay raise of 37 per cent.

✦ A daily wage raise of 25 centavos has been granted all miners by Cananea Consolidated Copper, operating at Cananea, Sonora, because of the higher price per pound of copper in New York.

✦ Negotiations are being made with Mazapil Copper by General Eulalio Gutierrez for the acquisition of machinery to equip a plant at Saltillo, Coahuila, to treat 200 to 400 tons of ore daily extracted by 300 cooperative miners in the Concepcion del Oro zone, Zacatecas. It is understood that the federal government intends to back the plan to the extent of 300,000 pesos (about $85,000).

✦ The 150-ton mill, designed by the Penhoel-Menardi Engineering Company, of Los Angeles, Calif., for the Explotadora de Mercurio de Huitzuco, S. A., has started production. The plant on the property is located at Huitzuco, Guerrero. Roberto Robles is in charge of operations.

✦ Average daily production of 160 tons, yielding 12 grams of gold and 100 grams of silver per ton, is being obtained by Compañia Minera de Los Azules, S. A., Henry S. Sweet, manager, at its Santa Barbara unit, Chihuahua. Filtration equipment is being installed at the cyanide plant to replace decantation.

✦ El Tigre Mining is producing 50 tons of gold-silver-copper ore at El Tigre, Sonora. E. R. Stanley is manager.

✦ Calabacillas Gold Mines is to complete installation of a 100-ton cyanide leaching plant at its Chihuahua unit early this year. This plant will augment facilities of a 125-ton treatment plant composed of a Marcy ball mill and a Hardinge mill driven by a Liberty engine fueled with charcoal gas, that operates 24 hours daily. George D. Jermain is superintendent at the property and J. C. Schell is mine superintendent. William N. Albee, of Detroit, is president and general manager.

✦ Cia. de Minas del Norte, S. A., Bernard Hudson, manager, has asked Federal sanction to discontinue working its iron deposits in the Sierra del Carrizal district, near Candela, Chihuahua, on the ground that operation is unprofitable. The company offers to employ workers laid off as a result of the suspension at its other mines at Saturno, in the Sierra Mojada district, Chihuahua.

New Zealand

✦ The Rimu dredge, Hokitika, New Zealand, which capsized on Aug. 18, is again in full operation. For the week ended Oct. 5, 56,095 cu.yd. was dug and 216 oz. of alluvial gold recovered, equivalent to 1.8 grams per cubic yard.

Canada

B. C. Nickel Mine Considering a 500-Ton Mill

EXTENSIVE DRILLING program has determined satisfactory information

✦ Diamond drilling at the B. C. Nickel mine, near Choate, in the Hope district, which has aggregated well over 100,000 ft. in the past two years, will be discontinued when the present contract expires. It is understood sufficient information is available on which to base marketing negotiations. A 500-ton mill is under consideration and Japanese firms are interested in purchasing the mine's production.

✦ Construction of two ore-sampling plants by the Government, at a cost not to exceed $100,000, has been authorized by the Legislature. The mills, one of which will be located in the North, probably at Prince Rupert, and the other in the southern interior, probably at Nelson, are intended to benefit prospectors and those developing claims to market small parcels of ore promptly and advantageously.

✦ Construction of an underground mill at the Big Missouri, in the Portland Canal district, with a capacity of from 500 to 750 tons, is proceeding rapidly. Two hundred men are engaged on the project. Foundations are being set for the power house and dwellings are being erected at the townsite. The tunnel to the mill chamber has been driven over 200 ft. from the portal. Its dimensions are 12x20 ft. The operation is controlled by Consolidated Mining & Smelting Company, of Trail, B. C.

✦ The 40-ton mill of the Welldun Mining & Milling Company at Stewart has been operated continuously this season, treating ore from a number of customs shippers in the North as well as the Dunwell mine. At the Georgia River, a 50-ton Hadsel dry-grinding mill is being installed by leasers. Further south, at the Porcher Island property of Reward Mining Company, two veins have been encountered in a lower level crosscut, which is being continued to a third vein, the main objective.

✦ Preparations for mining the rich Empire area of the Bralorne mine, Bridge River, have been completed down to the 10th level, it is learned from R. Bosustow, managing director, and work has been commenced to develop the ore to greater depth. The possibilities are considered good, as ore has been opened down to the 23d level to date at the Pioneer mine, adjoining to the east. The first step will be to sink a three-compartment shaft from the 8th level to the 13th, a further depth of 675 ft., and to drive crosscuts there to the Ida May and Blackbird veins. Connection will be made ultimately with the Empire shaft, 2,000 ft. to the north. The program will require seven or eight months to complete. In the meantime, production is higher than ever before, averaging about $225,000 a month, and the outlook is considered favorable, with ore valued at about $7,800,000 in reserve.

✦ In the Cariboo district at the Wingdam "deep lead" operation of Consolidated Gold Alluvials of B. C., Ltd., the final phase of preliminary development has been reached. The general manager, D. Campbell Mackenzie, reports that since July, 1934, about 350,000,000 gal. of water has been pumped from the workings, and the quantity of water remaining is believed to be comparatively small. The main reef drive, through which drainage is effected, has been driven 2,000 ft. beneath the gutter of Lightning Creek and a raise has been put up 71 ft. to a point level with the gutter. Local water is being drawn off at this point, and when this is completed the raise will be completed to the gold-bearing gravels and mining will commence.

✦ Ore reserves at the Vidette mine, near Savona, in the Kamloops district, are estimated at 37,812 tons averaging 0.705 oz. gold, of a value of $933,000. Somewhat over a year ago, reserves were practically exhausted, but since the solution of the fault problem by the late Gordon F. Dickson, managing director, development has proceeded rapidly. The value of production in the fiscal year ended Sept. 30, 1936, was $223,676, and net profit was $24,534. In November, 1,413 tons were milled. Output was valued at $38,734.

✦ The downward continuation of the new vein encountered at the 1,360 level at Ymir Yankee Girl, in the Nelson district, has been encountered by diamond drilling at the 1,500-ft. level, where excellent values were revealed. Ore reserves at Oct. 15 last were estimated at 226,200 tons, including 66,000 tons of probable ore. The grade of assured and reasonably assured ore was estimated to be 0.38 oz. gold, 2 oz. silver, 2 per cent lead, and 4 per cent zinc. The net value of output in the fiscal year ended Aug. 31, 1936, was $436,946, and net profit was $75,539. H. W. Seamon is general superintendent.

✦ Dentonia Mines, Ltd., recently exercised its option on a controlling interest in Durango Gold Mines, owning the Howard mine, near Ymir, for $165,000. It is planned to move the 100-ton mill now at the Dentonia property near Greenwood, in the Boundary district, to the Durango in the spring. In the meantime, a cyanide plant has been installed at the Greenwood property to treat about 50,000 tons of tailings. A. W. Davis will continue to direct the company's operations.

✦ Silicosis contracted by miners in British Columbia is to be made compensable under the Workmen's Compensation Act as a result of legislation passed by the provincial House in November. The new regulations provide that workmen exposed to the disease from Jan. 1, 1936, shall be entitled to compensation for total or partial disability resulting therefrom, to be paid out of a fund to be built up by assessments pro rata upon operators.

✦ In the Atlin district, the most northwesterly in British Columbia, placer mining activity has been the greatest in twenty years. Over two hundred men were employed on Spruce Creek alone. Considerable work has also been done in the McDame Creek area, in the Stikine district. The property of Cassiar Syndicate in this area has been optioned by the Consolidated Company. It is reached by airplane to Dease Lake.

✦ McKenzie Red Lake Gold Mines, in Dome Township, northwest Ontario, has increased the capacity of its cyanide mill from 150 to 200 tons per day. The additional ore is being provided from deeper mine development and exploitation. J. L. Ramsell is mine manager.

✦ Mine development at the property of the Chromium Mining and Smelting Corporation, according to a recent report issued by the company, has been retarded due to the delay in preparing the 27 mile railroad to transport heavy equipment to the property. The report states the smelter process is metallurgically correct, and the company has not installed all the necessary smelting and refining equipment at Sault St. Marie, for the production of low carbon ferro chrome; therefore, it has not been able to definitely ascertain costs. Professor W. G. McBride of McGill University has been retained as consulting mining engineer and M. J. Udy is consulting metallurgist.

Northwest Territories

✦ A gold strike about 500 miles north of Edmonton at Gordon Lake in the Northwest Territories was recently reported. The deposit lies between Lake Athabaska and Great Bear Lake. Prospecting has disclosed a vein from 32 to 48 in. wide, samples from which assayed high in gold. The Mining Corporation and the A. X. Syndicate, Ltd., both of Toronto, control 144 claims on the property. The Mining Corporation plans diamond drilling and more extensive geological work in the spring. J. H. C. Waite is president and general manager of the company. Last September prospectors, found by trenching, a well defined vein in this same area.

Copper Production Up To Meet Growing Demands

So-called world's production of copper as reported monthly so far this year by the Copper Institute, that accounts for at least 85 per cent of the total world's output, in short tons, follows:

	Blister Mine and Scrap	Refined Copper
January	134,867	131,384
February	130,852	131,500
March	136.555	138,934
April	135,891	130,065
May	142,846	131,560
June	130,822	134,969
July	122,319	119,450
August	130,809	128,630
September	140,720	134,334
October	154,340	150,671
November	169,218	159,426
11 Mo. Totals	1,529,239	1,490,923

Total stocks of refined copper reported by the Institute at the end of November amounted to 353,258 short tons, against 357,022 tons a month previous and 485,328 tons at Jan. 1, 1936.

Stocks on hand include "industry" as well as "non-industry" copper. Non-industry copper is metal stored for account of consumers, Commodity Exchange holdings, etc. Industry stocks, in the light of the present large volume of business, are small.

Yugoslavia

✦Trepca Mines, Ltd., milled 52,494 metric tons of ore in November, producing 6,061 tons of 78.15 per cent lead concentrates carrying 26 oz. of silver per ton, and 6,190 tons of 50.51 per cent zinc concentrates.

✦Zletovo Mines, Ltd., of Selection Trust's Yugoslavian group of lead-zinc companies, has increased its capital to £400,000 and sold 536,460 of the new 5s. shares for £160,938. These funds will be used to equip the mine with a treatment plant of 110,000 tons' annual capacity. Proved and partly proved ore reserves aggregate 948,070 tons averaging 11.5 per cent lead, 1.7 per cent zinc, and 3.5 oz. of silver per ton. It is planned to work the mine for lead and silver, disregarding the low zinc content of the ore.

●

More Tin Mines in Cornwall May Be Reopened

✦It is rumored that several more of the old tin mines in the Cornwall district of England will be rehabilitated and brought to production. South Crofty, which has been producing regularly for some years past, is recovering 26 lb. of black tin per ton of ore crushed.

Fiji Islands

Two Large Cyanide Mills For Island of Viti Levo

ORE RESERVES at Emperor and Loloma Mines warrant treatment plants

✦The recently published annual reports of the two most important Fiji mining companies—Emperor and Loloma, at Tova Tova, Island of Viti Levo—give valuable information. On the Emperor lode two adit drives and extensive crosscutting have proved 620,000 tons of oxidized ore and 50,000 tons of telluride ore, the combined assay of which is 10 dwt. per ton. The ore below the No. 2 adit level consists of sulphides, and no estimate of the quantity available has been made. The orebody is up to 450 ft. wide, but the main sheared zone is much narrower. A straight cyanidation plant with a capacity of 12,000 tons monthly is to be erected on the Emperor mine and will be in operation by September, 1937. The small pilot plant treated 18,680 long tons during the twelve months ended Sept. 5, 1936, for 10,635 oz. Average grade was 12.5 dwt. per ton and the extraction 91 per cent. Difficulties associated with the filtration of the clayey oxidized ore have been overcome. George J. Gray is manager. On the Loloma lease the lode has been proved on the 120-ft. level (bottom) for 900 ft. Further work will probably prove that there are several long oreshoots with barren zones between. Ore reserves are 105,130 tons, assaying 30 dwt. A treatment plant, the first unit of which will have a capacity of 500 tons weekly, will be in operation in June, 1937. The method will be dry crushing, roasting, fine grinding, and cyanidation. Power for both mills will be supplied from a central diesel-electric plant. W. J. Doran is manager.

Australia

✦Australian gold production for the nine months ended Sept. 30, 1936, has been given officially at 828,000 oz., compared with 630,000 oz. for the corresponding period of last year. Details are as follows:

State	Nine Months Ended Sept. 30 1935, Oz.	1936, Oz.
West Australia	444,700	608,000
Queensland	75,800	85,400
Victoria	64,100	75,600
New South Wales	34,400	43,000
Others	11,000	16,000
Totals	630,000	828,000

✦The yield for 1936 should exceed 1,100,000 oz., or 200,000 oz. more than 1935. Many mines, dredges, sluicing, and deep-lead projects have not yet reached the production stage, so that within three years a yield of 1,700,000 oz. is more than likely.

✦On the bottom level (No. 5) of Triton Gold Mines, N. L., near Cue, Western Australia, the lode has been proved to be 12 ft. 9 in. wide, assaying 8.2 dwt. The company is milling 6,900 tons monthly, for 2,400 oz., and is paying regular dividends. Ore reserves above No. 4 level are 157,000 tons assaying 8.3 dwt. A. A. McLead is superintendent and H. H. Dunkin metallurgist.

✦Wattle Gully Gold Mines, N. L., Chewton, Victoria, has placed in operation its new 20-head battery. From the first milling of 725 tons the yield was 321 oz. Development on the 575-ft. and 655-ft. levels is giving very good results. This mine should be a steady and profitable producer for many years. J. Till is mine manager.

✦The remodeled treatment plant installed at the Morning Star mine, Woods Point, Vic., has been placed in operation. After amalgamation the pulp passes to gravity tables, followed by flotation cells for the removal of an auriferous concentrate.

✦Ore reserves of South Kalgurli Consolidated, Ltd., which operates the only plant using dry-crushing, roasting and cyanidation at Kalgoorlie, Western Australia, has ore reserves proved and probable of 273,800 tons assaying 5.7 dwt. per ton. The company is treating 10,295 tons monthly at a profit of £4,000. F. G. Brinsden, of Fimiston, Western Australia, is general manager, and A. E. Paton is metallurgist.

✦In October, Yellowdine Gold Development, Ltd., operating the rich property at Yellowdine, Western Australia, treated 4,907 tons, assaying 17.1 dwt., for 2,395 oz. of bullion, valued at £19,612. The tailings, which are being stored pending the completion of the cyanide section, assayed 8 dwt. per ton.

✦Mount Lyell Mining & Railway Company, Ltd., Australia's only important copper producer, made a net profit of £187,291 for the twelve months ended June 30, 1936, compared with £65,912 in 1935 and £6,374 in 1934. The output of blister copper was 12,335 tons, against 13,927 tons in 1935. Costs have been greatly reduced by the change-over from stoping to open cutting in the method of mining. The company owes much to the excellent management of R. M. Murray.

Lead Mines Reopened In North Africa

HIGHER PRICES for metal plus demand encourage production

✦The devaluation of the franc and the higher price of the metal have caused several French-owned lead mines in North Africa to resume production, including Sidi-Bou-Aouance, Gran-Alfaya, and Bou Arfa, the last named being chiefly a producer of manganese ore. They are relatively small mines. Another lead mine, Minière de Djendli, may resume production soon.

✦The mill of Marlu Gold Mining Areas is so far completed that the first unit went into operation on Nov. 23. The second unit is expected to start in March; and the third and the fourth units will probably be in operation within a year. This company has proved 4,142,000 tons of 4.6-dwt. ore along its shear zone.

✦It has become evident that the extension of the Witwatersrand mining activities far to the west and southwest into the Orange Free State is more than a possibility, a prospect, or a contingency. Nearly all the farms over an area nearly 150 miles long are reported to be under option already. At different points eight diamond drills are already at work, the intention in one case being to drill to a depth of 5,000 ft. if necessary. The area between Krugersdorp and Lichtenburg is considered particularly promising, a belt 80 miles long and 2 wide there being regarded by many as the making of a huge new gold field. It is rumored that prospecting companies may be formed to explore the far western areas, similar to those which discovered and proved the copper wealth of Northern Rhodesia. Two such companies are said to be in process of formation.

✦The northwest shaft of Reitfontein (No. 11) Gold Mines has passed through several bands of the Kimberley Reef without disclosing any values, but the lowest band shows an average of 3.2 dwt. over a width of 17 in. This band will be explored. The shaft is now in the Kimberley shale.

✦Indications are that the dividend total of the Witwatersrand mining companies will be approximately the same for 1936 as for 1935. Though operations were on a larger scale and production was greater, the price of gold averaged over 2s. per ounce lower—just over 139s., against just over 141.6s. The recovery of the price to 142s., from a low of 137s. in September, came too late to bring up the average for the past year. Taken as a whole, the new taxation system has benefited the companies slightly. But it is pointed out that the balance between cost of production, including taxes, and the profit which remains, is so delicately adjusted that even a difference of a grain of gold per ton in the average yield, or a penny per ounce in the average price of gold, is distinctly perceptible when the net results for a year are computed.

✦The gold output of the Witwatersrand in November was 922,490 oz. and of adjacent districts 22,293, or a total of 944,783 oz. This compares with 977,425 oz. in October, the daily rate of production being approximately the same; and is 35,233 oz. greater than in November a year ago.

✦In Kenya Colony the Kimingini Gold Mining Company is beginning to get much better results. In November it produced 859.31 oz. of gold, against 669.38 in October. Heads averaged 6.46 dwt. and tailings 0.55 dwt. per ton.

✦Diamond mining in Africa seems to be on the eve of a considerable boom. Advices from Holland state that the demand for diamonds has become so great that a shortage of diamond cutters has developed and new men are being taught the trade.

✦There are now nearly 1,000 Africans engaged in winning diamonds in the Bonza River gravels in the Gold Coast Colony, in Central Africa. This is revealed in a review of the history of the Bonza diamond field by Dr. N. R. Junner, director of the Geological Survey, Gold Coast, just published in the latest bulletin of the Imperial Institute. Diamonds were first discovered in the Bonza River gravels by the Geological Survey in 1922. No further development took place until 1929, when other diamonds were discovered by Negro prospectors in the gravels of the Chirian and Bediabawu streams close to the Tarkwa-Anibil motor road, some 4 to 8 miles southwest of Tarkwa.

Early in 1933 the Africans began to work deposits on their own account, a venture which has proved so profitable that nearly 1,000 Africans are now engaged in winning diamonds, and the monthly output, which fluctuates rather widely, averages about 6,000 carats. The usual method of working, says the report, is similar to that employed by the Africans in winning gold from alluvial deposits. They work in parties of two or three—a man, his wife, and sometimes a child—and sink small isolated pits to the gravel, which is washed in wooden calabashes. The men do the digging and the women the washing. Their method of working is simple and rapid, but very wasteful. Approximately one-third of the diamonds in the treated gravel are lost and a large proportion of the gravel remains untreated owing to the haphazard methods used in selecting sites for pits and to the fact that only the richest sections of the gravels are chosen. "In my opinion there is at least twice as much gold, diamond and platinum wealth, which can be extracted economically, below the surface of South Africa than has been taken out in the last 60 years," said Dr. Hans Pirow, Government mining engineer, in an address on the "Mineral Wealth of South Africa." Some fifteen thousand million dollars' worth of gold and precious stones are still likely to be extracted from the Union's earth; that is to say, twice as much as had been extracted in the past, stated Dr. Pirow. He considered, however, that the value of the Union's payable base-metal resources is reaching the astronomical figure of $165,000,000,000. The values given by Dr. Pirow of the known base metals and some non-metallics are amazing, his estimates being:

Asbestos	$500,000,000
Lime	500,000,000
Manganese	1,000,000,000
Fluorspar	1,500,000,000
Chrome	1,500,000,000
Iron Ore	15,000,000,000
Coal	150,000,000,000

In addition, there were other minerals estimated at a value of several hundred millions of dollars. "If it were possible," the Government mining engineer concluded, "to assess this potential wealth in pounds, shillings, and pence, the sum arrived at would be equivalent to at least £20,000, or about $100,000, per head of every white man living within the boundaries of the Union. It is, however, clear that this vast wealth will be released only under favorable market conditions over a period of many decades, possibly of many centuries. In assessing the value of this wealth, it should be borne in mind that the mining industry distributes between 60 to 80 per cent of the wealth won from the earth in South Africa itself, and this fact may well be described as an outstanding feature of the industry. To my knowledge there are no other industries in this country, and few in other countries, that contribute so much to the direct revenue to the State and that distribute so much of the total wealth produced among the population of the country as a whole. We are also most fortunate in South Africa, and this is likewise a characteristic feature of the mining industry, in having cheap and unskilled labor, an adequate power supply, and means of transport which, although very expensive, do serve our general requirements."

PERSONAL ITEMS

A. W. Allen was recently in North Carolina on mill examination work.

E. W. Berry, mining engineer, recently joined the staff of the Batong-Bohay Mining Properties in the Philippines.

E. E. Stein, metallurgical engineer representing the Southwestern Engineering Company, of Los Angeles, is in Manila making a survey of the Philippine mining industry for his company.

George S. Rice, who for many years has been chief mining engineer of the United States Bureau of Mines, has been relieved of all administrative duties. Under the internal reorganization of the Bureau he will devote all his time to the International Mine-Safety Research, Mine-Safety Board, and special duties.

M. W. Coleman, chief engineer for the Oliver Iron Mining Company at Virginia, Minn., has been transferred to the Duluth offices of that company.

Victor J. Lynch, graduate of the Colorado School of Mines, has joined the engineering staff of Alvir & Company, of Manila, mining engineering consultants.

Roger Dering has resigned as general manager of California Standard Gold Mines Corporation, at Jamestown, Calif., because of ill health. He is succeeded by **A. E. Place.**

T. H. Oxnam, metallurgical engineer, Southwestern Engineering Company, Los Angeles, Calif., is now mill superintendent at the new 250-ton plant at the Eagle-Shawmut mine, Chinese Camp, Calif.

Edward K. Judd is now on the staff of the Division Engineer, United States Army, at Portland, Oregon, and is assisting in a survey of the mineral resources of the Northwest tributary to the Bonneville project, under the direction of Dr. Edwin T. Hodge.

C. Carleton Semple, having completed the construction of mill and cyanide plant for Cia. Aurifera Buldibuyo, Ltda., is now general superintendent for a newly opened gold mine in southern Peru, where a 150-ton mill will be built.

H. C. Harris and **John Pearson,** mining engineers who recently arrived in Manila, are now on the Balatoc staff. **S. I. Bowdwitch,** who came on the same boat, has been assigned to Benguet Consolidated as assistant geologist.

Frank A. Crampton, who formerly supervised the operation of the Remington Hill gravel mine, near Nevada City, Calif., has joined his brother in the formation of the engineering firm of Crampton & Crampton, with offices in the Chamber of Commerce Building, Los Angeles.

Mark Elliott, general superintendent of the Inter State Iron Company, the mining subsidiary of Jones & Laughlin, has announced the appointment of **Grover E. LeVeque** as his assistant, effective as of Dec. 1 last. Mr. LeVeque has been superintendent of the Hill Annex mine, at Calumet, Minn., for several years.

M. D. Harbaugh has assumed his new position as vice-president of the Lake Superior Iron Ore Association, and becomes executive in charge of its offices in the Hanna Building, Cleveland. He comes from Miami, Oklahoma, where he was secretary of the Tri-State Zinc and Lead Ore Producers Association.

MARION DWIGHT HARBAUGH

George W. Potter, Joplin, Mo., vice-president of Eagle-Picher Mining & Smelting Company, subsidiary of Eagle-Picher Lead Company, has been elected a vice-president of the parent company, succeeding **Frank W. Potts,** resigned.

R. E. Blosser, ingénieur-directeur in Africa for the Société Internationale Forestiere et Minière du Congo, at Tshikapa, in the Belgian Congo, is on leave for six months, his present address being 132 Blair St., Ithaca, N. Y.

G. A. Van Steenbergen, consulting engineer for Marsman Hongkong China, Ltd., and Marsman Investments Ltd., is conducting a preliminary inspection in the Dutch East Indies to ascertain the extent of mining prospects in that territory.

Harry Kamprath will sail for Germany from Los Angeles via the Panama Canal, at the end of the current month, to take a position as metallurgist with the department of Mining Administration of the State of Saxony (Sächsische Landesberg-verwaltung) in Dresden, Germany.

James F. McCarthy, of Wallace, Idaho; and **Roger Oscarson, Captain C. J. Mabbut,** and **Richard Marsh,** of Spokane, Wash., have been elected directors of the Northwest Mining Association for a period of three years. With eight hold-over members and three past presidents, they will form a board of fifteen members.

E. R. Boericke has joined the mining organization of R. Potter Campbell, Inc., as assistant mining engineer to **Fred Farish,** of that company. Previously for fifteen years he had been employed by the Primos Company, of Philadelphia, in charge of that company's operating mines and mills, also directing its examination and development programs in the United States, Canada, Mexico, and Asia. Mr. Boericke expects to leave shortly to examine some properties for the company in Canada and the northwestern part of the United States.

R. W. Diamond, general superintendent of concentration and of chemical and fertilizer plants, has been appointed assistant general superintendent of Trail plants of the Consolidated Mining & Smelting Company of Canada, Ltd., succeeding the late **George E. Murray.**

J. B. Knaebel, manager of the East Mindanao Mining Company, writes from Placer, Surigao, on the island of Cebu, under date of Nov. 9, that he is leaving the Philippines shortly for a vacation in the United States. His address here will be care of Ernest Knaebel, 3707 Morrison St., Washington, D. C. He adds that the company's new 100-ton cyanide plant, construction of which was begun last February, has been in operation since about Sept. 1 last. It was only two and a half years ago that he first went to the property, which at that time was an undeveloped prospect with 200 ft. of work done upon it and the principal vein entirely unknown.

R. W. Crosby, formerly general superintendent of Suyoc Consolidated, operating near Baguio, in the Philippines, has been promoted to assistant to **J. O. Enberg,** manager of the northern division of Marsman & Company. **L. W. Robinson,** former mine superintendent for Suyoc Consolidated, is now general superintendent, and **C. C. Heinrich,** mine shift boss, is mine superintendent.

George Mackenzie, chairman of the board of Tanganyika Central Gold Mines, Ltd., and **George D. Stephen,** the company's consulting engineer, recently visited the company holdings at Sekenke, Tanganyika, making the trip both ways from Johannesburg by air.

John Herman was elected chairman of the Los Angeles section of the A.I.M.E. at the annual meeting held in Los Angeles on Dec. 16. He succeeded **Robert F. Linton. John F. Dodge** was elected vice-chairman and **J. Jocelyn** secretary and treasurer. **Dr. Thomas**

Nixon, professor emeritus of political economy of Harvard University, addressed the meeting on "What the Government Can Do for Private Industry."

Justice R. A. E. Greenshields, of the Quebec, Canada, Superior Court, and **Charles Warren,** former Assistant Attorney General of the United States, have been appointed national members of the Trail smelter tribunal, to adjudicate damage claims arising through the operation of the smelter. They will select a third, neutral, member of the tribunal, which is expected to begin hearings early in January, 1937.

A. S. Baillie, former auditor of the Granby Consolidated Mining, Smelting & Power Company, and more recently co-liquidator, has been appointed vice-president and general manager of the reorganized company and is supervising the rehabilitation of the company's copper mines and 2,500-ton concentrator at Allenby, British Columbia.

Hugh W. Coke, metallurgist and mill superintendent at the plant of Treadwell Yukon Company, Ltd., Tybo, Nev., described in the December issue of *E.& M.J.*, is on a leave of absence from Tybo doing metallurgical work for the Idaho-Maryland Mining Corporation at the new mill placed in operation recently at Forbestown, Calif.

W. L. Taylor, of Hibbing, Minn., was elected chairman of the Minnesota Section of the A.I.M.E. at a meeting of the Section held on Dec. 8 at the University of Minnesota. **E. W. Davis** and **Perry G. Harrison** were elected vice-chairmen. Mr. Davis is in charge of the experimental school at the University and Mr. Harrison is manager of the Evergreen Mining Company at Crosby, Minn.

Adolph Kamphausen has accepted a position as metallurgist with the Copper Range company at Painesdale, in the Michigan copper district. Upon his graduation, Mr. Kamphausen was employed as underground foreman by a government-controlled mining company at Herne, Westphalia. He was attracted to the Lake Superior district by its mining and metallurgical facilities and spent the first few weeks of the fall term this year at the Michigan College of Mining and Technology, at Houghton, where he was engaged in the metallurgy department.

Colin G. Fink, professor of electrochemistry at Columbia University, has planned a Western trip, during which he will speak before local sections of the American Institute of Mining and Metallurgical Engineers, and university groups, on the following subjects: "Research in Electrochemistry," "Electrochemistry in Industry," "Corrosion," and "Chemistry in Art." His schedule follows: Jan. 13, at Minneapolis, Minn., before the local section of the A.I.M.E.; Jan. 18, at Butte, Mont., morning, before the School of Mines; evening, in the same city, before the A.I.M.E.; Jan. 20, at Spokane, Wash., before the A.I.M.E.; on the 22d, at Seattle, Wash., also before the A.I.M.E.; on the 28th, at San Francisco, before the A.I.M.E.; and on Feb. 1, at Reno, Nev., before the A.I.M.E. and the University of Nevada.

OBITUARY

Robert Emmet Tally, of Prescott, Ariz., former president of the United Verde Copper Company, who in 1931 was president of the American Institute of Mining and Metallurgical Engineers, died in New York City on Dec. 14. Mr. Tally was born in Virginia City, Nev., and received the degrees of

ROBERT EMMET TALLY

WILLIAM HARRIS GILL

mining engineer and bachelor of science from the University of Nevada in 1899. He became interested in metallurgy and engineering and in 1905 joined the United Verde Copper Company as assistant superintendent of mines. He became assistant general manager of the company in 1916, general manager in 1922, and president in 1930. Mr. Tally retired five years later when the United Verde properties were purchased by the Phelps Dodge Corporation. He also was a former president of the Clarkdale Improvement Company, the Upper Verde Public Utilities Company and the Verde Tunnel and Smelting Railroad Company. Mr. Tally was president of the American Mining Congress in 1929 and 1930 and also was a member of the Mining and Metallurgical Society of America.

Robert Dunn, Deputy Minister of Mines for the Province of British Columbia, died in Victoria on Nov. 26 last. He was born in Toronto in 1884. After a newspaper career in Victoria, he became secretary to the late William Sloan, Minister of Mines, in 1916. He was promoted in 1925 to the post of deputy minister. For years while secretary to the Minister he was a valued mining correspondent of *Engineering and Mining Journal.*

John I. Kane, mining engineer, for many years associated with the American Smelting & Refining Company in Texas and Mexico, died at Saranac Lake, N. Y., on Dec. 21, in his fiftieth year.

William Harris Gill, general manager of the National Zinc Company at Bartlesville, Okla., died on Dec. 9 at New Orleans, age 55. He was born at Rolla, Mo., and graduated from the School of Mines there. For 29 years he had been identified with the zinc-smelting industry of Oklahoma.

Gordon F. Dickson, managing director of the Vidette mine, British Columbia, died on Dec. 9 at the mine. He was born at St. Kilda, Australia, in 1864, and graduated in mining engineering from the Ballarat School of Mines, Victoria, New South Wales. He held numerous managerial positions in his native land until 1910, when he went to Rhodesia in a consulting capacity for the London and Rhodesian Company. He went to Canada in 1916.

George E. Murray, chief metallurgist of Consolidated Mining & Smelting Company of Canada, and assistant general superintendent of the company's Tadanac plant, died on Nov. 8, 1936, at the age of 47.

William Campbell professor of metallurgy at Columbia University, New York, since 1914, died suddenly on Dec. 16 of a heart attack. He was 60 years old. A native of Gateshead-on-Tyne, England, Professor Campbell held degrees from King's College, London, and Durham University when he came to Columbia in 1902 as a University Fellow. He became an instructor in metallurgy in 1904, adjunct professor, 1907; associate, 1912; full professor, 1914, and, in 1924, the first Howe professor of metallurgy, assuming a new chair created in honor of the late Henry Marion Howe, who had been professor of metallurgy, 1897-1913. In the last year of the World War, Professor Campbell was metallurgist to the Brooklyn Navy Yard. He was metallographer for the technologic branch of the United States Geological Survey, 1907-11, and held a similar post in the Bureau of Mines, 1911-21. In 1903 Professor Campbell won the Saville Shaw Medal of the British Society of the Chemical Industry and, in 1905, the Carnegie Scholarship of the Iron and Steel Institute.

NEW BOOKS

Some Mining Frontiers

SETTLEMENT AND THE FOREST AND MINING FRONTIERS. *By A. R. M. Lower and Harold A. Innis. The Macmillan Company of Canada, Ltd., St. Martin's House, Toronto, Canada. Pp. 424. Illustrations 49. Price $4.50.*

This book is the ninth and concluding volume of a series on "Canadian Frontiers of Settlement," portraying the social and economic aspects of different types of industry in the settlement of a pioneer country. Previous volumes have been devoted primarily to agriculture and prairie settlement. The current volume deals with the forest and mining frontiers, the latter being of primary interest to readers of this journal. No attempt is made to tell the full story of mining in Canada; the authors seek, rather, to analyze the significant problems of settlement as revealed in striking examples of the mining frontier.

The Yukon Territory, the Kootenay region of British Columbia, and northern Ontario are selected for treatment. The authors delve deeply into the historical development of these areas, tracing the parallel growth of services of supply, transportation, and communication, shifts in population, changes in community life, and the rise of related industries and trade.

Placer gold was the lure of the Yukon. Examination of the effects of the Klondike gold rush on the development of Canada is referred to as "a study in economic dynamics." The movement was cyclonic in intensity, and when it had spent its force it left in its wake "a vast shell of equipment in terms of buildings, transport facilities, and mining equipment." But in its brief period it exhibited all the social and economic tendencies observed in long-run trends.

The foundation for the development of the Kootenay region was likewise placer gold, but other natural resources of the area were subsequently developed to give it a position of more permanent significance. Lode mining of lead-silver ores stimulated the development of heavy industries and the establishment of thriving urban communities. Railroad construction gave a great impetus to industry and trade. Coal deposits were opened and hydro-electric power was developed. In short the Kootenay region ultimately experienced the benefits of modern industrialism.

In contrast to the Yukon and the Kootenay, metal mining in northern Ontario owes its expansion to construction of railroads to open up agricultural territory. Both Sudbury and Cobalt were discovered as a result of railroad construction. The combination of precious-metal deposits and rail transportation led to rapid settlement and development of the region. Cobalt experienced all the evils of a boom period in a rich mining camp—labor troubles, "wildcatting," "high-grading," "blind pigs," lack of sanitation—all of which had to be met by legislation. But the ultimate effect of silver discovery at Cobalt was the general extension of mining in Ontario, particularly of gold, at Porcupine and Kirkland Lake. Subsidiary growth of capital-goods industries, power development, and agriculture followed rapidly in the region, as in the Kootenay.

The volume closes with a chapter on the New Frontier—the areas lying far north of present settlement and transportation—and discusses the factors that may be expected to contribute to their development.

An Indian Guide

INDIA'S MINERAL WEALTH. *By J. Coggin Brown. Oxford University Press, New York. Pp. 335. Price $5.*

As superintendent of the Geological Survey of India, the author presents this "guide to the occurrences and economics of the useful minerals of the Indian Empire" with an authority that recommends it to the reader. The volume's four parts cover, respectively, the mineral fuels; the metals and their ores; other useful minerals, such as those used in building construction, agriculture, ceramics, glassmaking, and other industry; and gems and semiprecious stones. The book is far from being merely statistical or dryly descriptive. It abounds in references to such matters as early origins and native customs, so as to give the text an Oriental flavor.

For Civil Engineers

ENGINEERING GEOLOGY. *By Heinrich Ries and the late Thomas L. Watson. Fifth revised edition. John Wiley & Sons, Inc., New York. Chapman & Hall, Ltd., London. Pp. 750. Figs. 271. Plates 88. Price $5.*

The first edition of this book was published in 1914. The fifth, in 1936, is testimony not only to the excellence of the text but also to the wisdom of the authors in devising a special course in geology for civil engineers. Their pioneer work in this direction has gradually found favor in universities other than their own. The importance of geology to the civil engineer is readily appreciated when one considers the structure of rocks in relation to tunnels, dam and reservoir foundations, and other structures which the civil engineer is called upon to build. Like the text, the illustrations in the book are exceptionally pertinent to the work of the civil engineer, and greatly aid the presentation of the subject.

The Dust Problem

INDUSTRIAL DUST—Hygienic Significance, Measurement, and Control. *By Philip Drinker and Theodore Hatch. McGraw-Hill Book Company, New York. Pp. 316. Price $4.*

Two capable men here discuss a subject of steadily increasing importance, and well this is, in order that as large and influential a group of readers as possible may be drawn to learn what they have to say. The menace to industry from the possible exploitation by demagogue, unprincipled attorney, and workman faker of the opportunity afforded by the problem of dust diseases is best to be met by studying industrial dust and devising ways of controlling it and minimizing its effects, rather than by argument or fulminations—this wholly aside from any humanitarian considerations.

The scope of the book is indicated by the chapter headings: 1. Physical Properties of Dusts, Fumes, and Mists. 2. Effects of Dusts and Fumes Upon Man. 3. Physical and Chemical Factors in Pneumoconiosis. 4. Permissible Dustiness. 5. The Dust Survey. 6-7. Dust Determination. 8. Determination of Particle Size. 9. Chemical and Mineralogical Analyses. 10. Control of the Dust Hazard. 11. Design of Local Exhaust Systems. 12-13. Air-cleaning Apparatus—Filtration. 14. Dust Respirators and Air Masks.

A Russian Text

FLOTATION (in Russian). *By V. J. Trushlevich, E.M., Professor of Ore Dressing, Institute of Mines, Moscow, U.S.S.R. Published by ONTI-NKTP, Moscow, 1935.*

In this Russian volume of 615 pages there is a design of a textbook for engineering students specializing in flotation. The introductory chapter explains the past and present status of flotation in the Soviet Union, with a brief historical outline, and defines flotation, as "a process of concentrating finely dispersed material." The place of flotation in the more general scheme of ore dressing is lightly touched upon. The second chapter treats of the theoretical

basis. including the physico-chemical, adsorption, gas, angles, and colloidal and electrostatic influences. Then follow chapters on Reagents and The Preliminary Steps in Determining the Floatability of an Ore, and Flotation Machines and Accessory Apparatus. Two chapters are devoted to the practices of a number of mills, Soviet and foreign, and results of laboratory tests on minerals and their combinations. In conclusion, Professor Trushlevich makes clear the dominant rôle of flotation in the concentrating plants of the U.S.S.R. and lists ten points of what he believes will be the future developments in this field.

Two Soviet flotation machines are described in the book, as well as the interesting laboratory work on reagents by Shvedov and Erchikovsky and on theoretical measurements by Rebinder and Talmud and Frumkin. There is also included a brief table of physical and chemical data of minerals, and another of some of the Soviet flotation plants.

The book is generously filled with material previously published in the Russian and foreign literature, especially from American technical and trade publications. It should serve very well the long-felt want of the Soviet student of engineering in flotation.

E. P. MEYER.

A Cross-Section

STOPING METHODS AND COSTS. *By Charles F. Jackson and E. D. Gardner, Bulletin 390. United States Bureau of Mines, Washington, D. C. Pp. 296. Price 25c.*

The great contribution to the mining industry made by the United States Bureau of Mines in the extensive series of Information Circulars on mining methods at different mines, publication of which began in 1928, has been pointed out more than once in the past by *Engineering and Mining Journal.* The Bureau undertook and admirably performed a task that was impossible for any magazine covering so complex and so extensive an industry, if only because a single one of many of the eighty-odd circulars would have required for its presentation the entire space available in an average issue. Subsequently, the Bureau, taking this series as a whole, proceeded to cut horizontal sections through it, so to speak, summarizing in each the practice employed in a given operation at the many different properties. In preparing these summaries, information drawn from field studies and data published outside the series were also included. These summaries have dealt separately with each of the principal underground mining methods. The present paper, Bulletin No. 390, summarizes "stoping methods and costs." The value of such a bulletin is great and in no way to be gaged by the nominal price the Superintendent of Documents sets upon it.

THE FINANCIAL POST SURVEY OF MINES—Canada and Newfoundland. *The MacLean Publishing Company, Ltd., Montreal, Canada. Pp. 312. Price $2.*

This is the eleventh annual edition of The Survey, which is practically a handbook on the principal mining companies of Canada and Newfoundland. About 2,000 active companies are listed. There are in addition statistical data on Canadian metal production, price range of metals, dividend record of metal mines, price range of mining stocks, and other facts relating to the mining industry. Numerous maps are included, showing the location of producers and prospects in the principal mining areas.

FIRST AID FOR MINERS—ELEMENTARY, PRACTICAL. *Published and issued by The Prevention of Accidents Committee of the Rand Mutual Assurance Company, Ltd., Johannesburg, South Africa, and authorized by the South African Red Cross Society. Pp. 92.*

PUBLICATIONS RECEIVED

Silver Mining Industry in Canada, 1935. A Summary Review. Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa. This also includes data on production of lead, zinc, arsenic, and cobalt.

Annual Report of the Minister of Mines of British Columbia, 1935. Minister of Mines Office, Victoria, B. C. Price 50c.

Newfoundland Geology. Bulletin No. 3, on the Bay of Exploits area, by G. R. Heyl, and Bulletin No. 4, on the southern half of the Bay of Islands igneous complex, by J. R. Cooper. Department of Natural Resources, Geological Section, St. John's. Pp. 66 and 62 respectively.

Union of South Africa, Mineral Resources of. Compiled by the Geological Survey, Department of Mines, Pretoria, South Africa. Pp. 454. Price 1s.

Some Magnetometric and Gravimetric Surveys in The Transvaal. By O. Weiss, D. J. Simpson, and G. L. Paver. Department of Mines, Union of South Africa, Johannesburg. Pp. 27 and 9 plates. Price 2s.

Geology of Peru. "La region aurífera de Marcapata," by J. F. Aguilar Revoredo, and "Los lavaderos auríferous de los ríos Pachitea y Napo," by L. F. Aguilar. Bulletin No. 116, Cuerpo de Ingenieros de Minas del Peru, Lima.

Hog Heaven Mining District, Flathead County, Montana, Geology and Ore Occurrence. By Philip J. Shenon and A. V. Taylor, Jr. Montana Bureau of Mines and Geology. Memoir 17. Pp. 26.

Bayard Area, Central Mining District, New Mexico; Geology and Ore Deposits of. By S. G. Lasky, Bulletin 870. Pp. 144. Price 80c.

Organ Mountains, The Geology of. By K. C. Dunham. Bulletin II. New Mexico School of Mines, Socorro, N.M. Pp. 272.

U. S. Bureau of Mines, Washington, D. C., has recently issued the following Information Circulars and Reports of Investigations:

Hot-Milling of Rock-Drill Bits at the Mines of the Vinegar Hill Zinc Co., Platteville, Wis. By Wing G. Agnew. I. C. 6907.

Gold Mining and Milling in the Black Mountains, Western Mojave County, Ariz. By E. D. Gardner. I. C. 6901.

Underground Mill at the Doyle Mine, Shullsburg, Wis. By Wing G. Agnew. I. C. 6908.

Shaft Sinking With a Shot Drill, Idaho-Maryland Mine, Grass Valley, Calif. By J. B. Newsom and C. F. Jackson. I. C. 6923.

Reconnaissance of Mining Districts in Pershing County, Nevada. By W. O. Vanderburg. Pp. 52. I. C. 6902

Consumption of Primary and Secondary Tin in the United States in 1935. By E. W. Pehrson, J. B. Umhau, and M. E. Trought. Pp. 12. I. C. 6930.

Flotation of Vermont Talc-Magnesite Ores. By J. Bruce Clemmer and S. R. B. Cooke. R. I. 3314.

Electrometallurgical Investigations. Progress Reports, Metallurgical Division. By J. Koster, S. M. Shelton, and R. G. Knickerbocker. R. I. 3322.

U. S. Geological Survey has recently issued the following papers, which are to be obtained from the Superintendent of Documents, Washington, D. C.:

Mineral Resources of the Region Around Boulder Dam. By D. F. Hewett, E. Callaghan, B. N. Moore, T. B. Nolan, W. W. Rubey, and W. T. Schaller. Bulletin 871. Pp. 197. Price 45c.

Mineral Deposits of the Ruby-Kuskokwim Region, Alaska. By J. B. Mertie, Jr. Bulletin 864-C. Pp. 115–255. Price 25c.

Canada's Department of Mines, Geological Survey, at Ottawa, has recently published the following papers:

Mineral Deposits in Renfrew County, Ont., and Vicinity. By B. C. Freeman. Memoir 195. Pp. 34. Price 25c.

Mining Industry of Yukon, 1935. By H. S. Bostock. Memoir 193. Pp. 12. Price 10c.

Gold Occurrences of Ontario East of Lake Superior. By E. D. Kindle. Memoir 192. Pp. 167. Price 50c.

Carmacks District, Yukon. By H. S. Bostock. Memoir 189. Pp. 67. Price 25c.

Geology and Mineral Deposits at the Mine of B. C. Nickel Mines, Ltd., Yale District, B. C. By H. C. Horwood. Memoir 190. Pp. 15. Price 10c.

EQUIPMENT NEWS

Conveying Materials in a Moving Endless Rubber Pipe

A NEW METHOD of conveying liquids or solids is found in the Johns Conveyor, made of rubber, manufactured by Johns Conveyor Corporation, 605 Broad St., Newark, N. J. When in operation it resembles a moving pipe line having four longitudinal rubber ribs which effect a twisting motion as it travels from pulley to pulley. The pipe line has two equal halves throughout its entire length, held together by double tongue and grooves. The halves can be separated and put together by forces exerted as the pipe passes over or between grooved pulleys.

Liquids or solids can be loaded into the receiving part of the line, and when sealed tight with the other half can be caused to make any desired turns by passing around pulleys that are so placed as to convey the material in any direction. Other receiving set-ups can be arranged, however, depending upon the individual problem. Before receiving material, the halves separate, one going through the hopper and the other over pulleys.

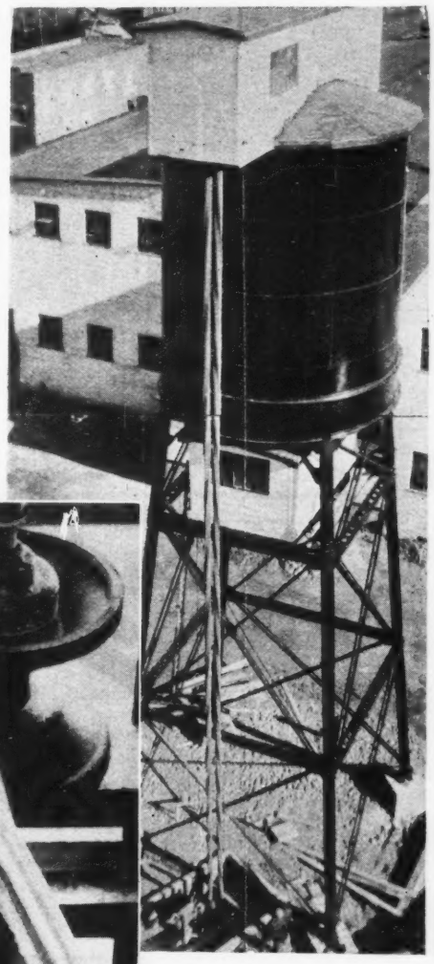


FIG. 1—CONVEYING CRUSHED limestone up 87 ft. to the top of a storage bin on the property of a Canadian gold mining company

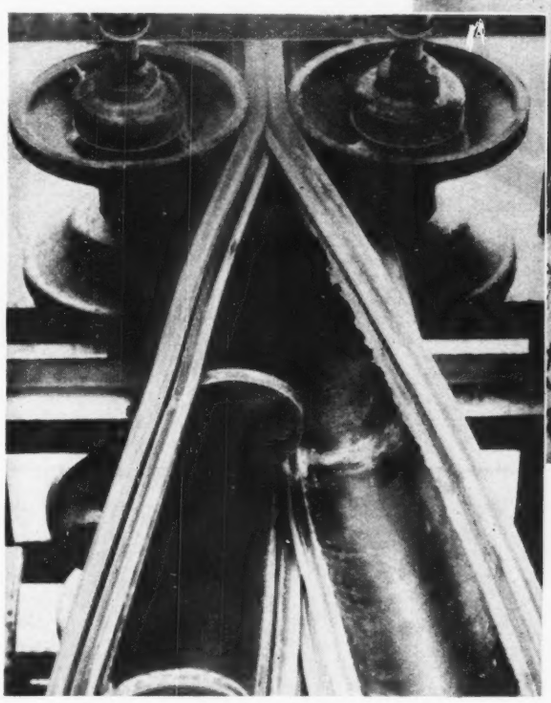


FIG. 2—TWO PULLEYS force the tongue and groove of each half of the 4-in. rubber conveyor together after the load has been discharged. The disk-like partitions serve to pick up a full load when passing through the hopper

The conveyor receives solid material from a hopper the mouth of which is the same width as the inside diameter of the pipe. The lower half (designated as such when passing through the hopper) is fitted with disk-like partitions or flights which serve to pick up a full load when passing through the feed hopper. These disk-like partitions form individual compartments, thereby avoiding slipping and packing of the material on vertical lifts. When the pipe is loaded and starts to pass beyond the edge of the hopper, the upper tongued and grooved half runs underneath a pulley which joins the two halves tightly together. It is now a loaded pipe line twisting on its way as it passes horizontally over guide pulleys spaced about 10 ft. apart, or it continues vertically as shown in Fig. 1.

Each half portion has a rubber rib in which is embedded a steel chain which exerts a compressing and tightening action, keeping the two halves together. The system is noiseless, clean, and free-moving, and it moves around the pulleys with little effort and wear. The pulleys have anti-friction bearings and are fastened in standard frames which are hung from existing structures by hangar bolts with take-ups which afford adjustment for proper tension and which at the same time do away with rigidity and permit free movement. This is said to eliminate any possible transfer of vibration to or from the conveyor. Power consumption is reported much less than a combination of conveyor or elevators, because of a lower friction factor.

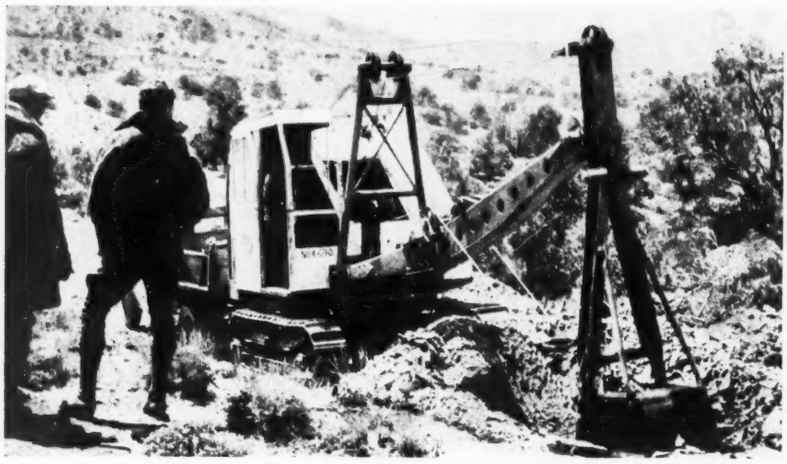
When the line arrives near the point of discharge, the pipe is opened by pulleys and empties its load as the two halves separate, after which the halves meet between two pulleys (Fig. 2), where they are joined together. The pipe is now on the empty circuit and returns toward the hopper. If there are 200 ft. of conveyor belt only 100 ft. is loaded while the remainder is on the empty circuit.

The manufacturers state this type of conveyor is particularly useful for handling wet mixtures and serves as a pump for removing water from mines, deep wells, and quarries. In handling water or liquids the partitions in one half of the tube are said to be firmly compressed against the other half when the tube is twisted, so that each compartment carries its own particular load of water independently of the other. Therefore, the internal pressure at the bottom of a 1,000 ft. lift is no more than at the top. It is said to resist abrasion and will not stain or discolor material which is brought into contact with it, and it can easily be kept clean.

When traveling vertically the pipes require only sufficient space to permit free movement of the empty and loaded lines. An installation requiring a 4-in. line would require space measuring about 18 in. long by 12 in. wide when running vertically or inclined. When operating horizontally, supporting idler pulleys are placed about 10 ft. apart and the structure to support this measures in cross-section about 24 in. square.

A table giving details of various Johns Conveyor capacities follows:

	Materials Weighing 100 Lb. per Cu. Ft. at Conveyor Speeds in Ft. Per Min.					Materials Weighing 50 Lb. per Cu. Ft. at Conveyor Speeds in Ft. Per Min.				
Conveyor Size, inches	100	200	300	400	500	100	200	300	400	500
	Capacity in tons per hour									
2	6	12	18	24	30	3	6	9	12	15
4	24	48	72	96	120	12	24	36	48	60
6	54	108	162	216	270	27	54	81	108	135
8	96	192	288	384	480	48	96	144	192	240
12	216	432	648	864	1080	108	216	324	432	540



A TRENCH HOE built by the P & H Company, of Milwaukee, Wis., is being used on a gold sampling job by a mining company in Nevada. The machine digs a ditch 34 in. wide and from 8 to 10 ft. deep into the shale. The equipment is said to be light weight due to welding and new alloy steels and the performance of this machine is said to have been 7,000 ft. of trenching in two and one-half months.

Light-Weight Core Drill

Sullivan Machinery Company, of Michigan City, Ind., announces the new No. 12 core drill, which is said to have a 50 per cent increase in drilling speed over its other small drills. This adaptable, light-weight machine is 4 ft. 7 in. high and weighs little over a thousand pounds and is either gasoline or electric driven. Four compact parts—hoist, engine, swivelhead, and frame—are said to be quickly dismantled for easy transportation. The hydraulic or screw feed swivelhead can be set for drilling at any desired angle and is said to permit efficient operation on either soft or hard formation.

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Diesel Engine

Ingersoll-Rand Company, 11 Broadway, New York, recently announced its Type S diesel engine. This engine is an improved design which is said to be thoroughly modern in all respects. It is of the vertical, four-cycle, single-acting, solid-injection type design to run at medium speeds and built for heavy-duty, continuous service. Type S engines are made with 3, 4, 5, 6, and 8 cylinders for ratings from 150 to 460 hp.

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Safety Hat

The McDonald safety hat, announced by the Davis Emergency Equipment Company, Inc., 55 Van Dam St., New York, is molded of duralumin metal. The manufacturer lists the following six advantages for its product: (1), It is light in weight, durable, waterproof and non-corrosive; (2), Hat will absorb the force of a blow by denting slightly when hit; (3), Polished metal surface reflects heat and makes the hat approximately 15 deg. cooler; (4), Safety cradle for the head has a six-point suspension, permitting a greater blow distribution; (5), The floating head band is interchangeable and comfortable, for it fits any size or shape of head and provides more ventilation; (6), A slightly flexible molded rubber brim prevents hat from being easily knocked off. A chin strap may be easily attached.

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Large-Diameter Drill

The new drill machine, the 42–T, announced by Bucyrus Erie Company, Milwaukee, Wis., is said to swing up to 6,000 lb. of cable tools, and provides tremendous drilling energy at the bottom of holes 9 in. and 12 in. diameter. The Bucyrus-Armstrong rubber shock-absorbers are said to give the type of snap to the tools which old-time drillers recognize as producing most footage per day. Widespread, full-length crawler mountings are said to afford easy and quick moving. All-steel welded construction throughout gives the machine unusual strength and long life, and the maintenance expense is said to be low. Among the new features introduced in the 42–T is a power-driven tool wrench which sets up and breaks tool joints entirely by power. Raising the 48–ft. telescoping derrick is also done by power from the engine. A choice of 80-hp. diesel engine or powerful electric motor is offered in the 42–T and ample power is said to be provided with these power plants to overcome the conditions which this new large drill is required to meet.

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Light-Weight Wagon-Mounted Drill

Ingersoll-Rand, Phillipsburg, N. J., announces a new light-weight wagon mounting for fast and powerful rock drills. It is said to fill the gap between the large I-R drills and the hand-held Jackhamer. It is reported to handle 20-ft. steels and will accommodate a 6-ft. steel change. The new unit is said to have great versatility, with a positive feed at any angle. Feed is by air motor, with a range of feed pressure from 1 to 1,000 lb. A self-locking worm drive permits feeding the drill up to the rock exactly as with a hand-cranked drill, said to be a distinct advance in the method of feeding drills on wagon-drill service. The new mounting provides an easier and faster method of handling the heavier drills, which is reported to result in increased yardage with less fatigue to the operator. The mounting can be equipped with pneumatic tires, which make it much easier to move or transport.

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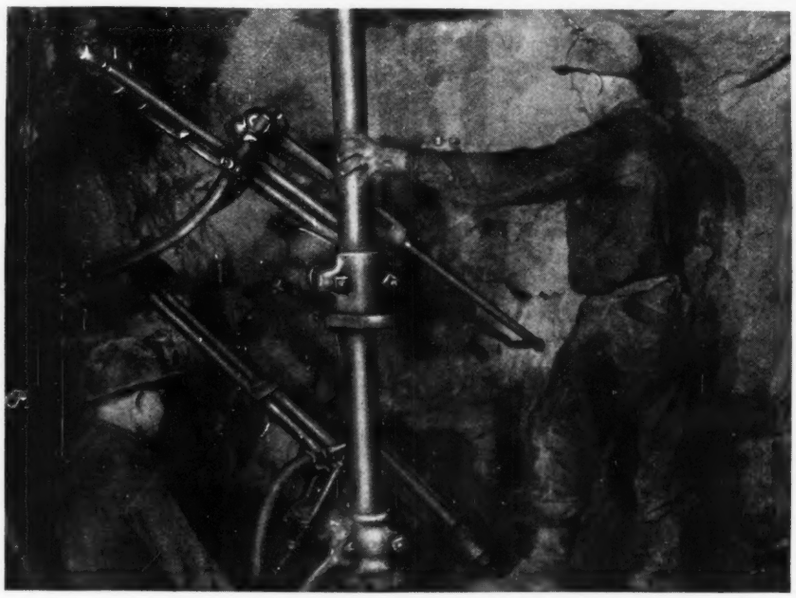
Welder

The Harnischfeger Corporation, of Milwaukee, Wis., announces a new line of simplified P&H Hansen "Smootharc" welders featuring single current control, self-excitation, and internal stabilization,



TWO MOUNTED DRILLS, here shown, are known as Autodrifters, a new product announced by the Chicago Pneumatic Tool Company, 6 East 44th St., New York City. They are said to automatically maintain the drill in a correct striking position, regardless of drilling speed or angle of hole, thereby eliminating hand cranking

SIMPLIFIED POWER CONTROLS are now furnished as standard equipment by the Link-Belt Company of 307 North Michigan Ave., Chicago, Ill., on their shovel-dragline crane models K-40, K-45, K-48 and K-480. The devise permits operation of the shovel by short easy throw levers, and the company lists the following advantages: 1—elimination of operator fatigue, 2—speedier operation, 3—greater output.

the qualities the manufacturer recommends for fast, steady welding, deep penetration, and uniform metal deposit. This new line of welders is built in two styles: vertically mounted in 75-, 100-, and 150-amp. capacities and horizontally mounted in 200-, 300-, 400-, and 600-amp. sizes. Both models are said to be uniformly and compactly built, and streamlined to facilitate portability.

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Conical Hole Plate

The Abbe Engineering Company, 50 Church St., New York City, announces a perforated plate specialty which is said to have determined good results for pulverizers, hammer mills, filters, centrifugals, dryers and other similar machines. The advantages of this plate the manufacturers list as follows: (1) Openings such as 0.01 in. to 0.02 in. may be supplied in all metals, including stainless steel, hitherto unobtainable. (2) Plate thicknesses much greater than available from ordinary sources of supply can be supplied. (3) The conical shape of the holes prevents blinding of the screen perforations.

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Diamond Drill

The Ingersoll-Rand Company, Phillipsburg, N. J., announces a diamond drill said to be equipped with a master gage that registers directly in pounds the pressure of the diamond bit against the rock. Thus, when a soft formation or seam is encountered during drilling, an immediate reaction is indicated on the gage. The hydraulic control mechanism permits the drill, under such conditions, to accelerate its feed, but does not allow the string of tools to drop. Known as the "Coroc," the drill can be operated by gasoline or kerosene engine or electric motor drive. Hoisting of the tools is facilitated by an integral hoist particularly suited to this type of work. Holes to 1,150 ft. producing cores $\frac{7}{8}$ in. in diameter, or shorter holes with larger cores up to 3 in. in diameter, are possible.

INDUSTRIAL NOTES

Industrial Wiring Survey. Anaconda Wire & Cable Company, 25 Broadway, New York, N. Y., has just published an elaborate check list to enable managers of industrial plants to make a complete and intelligent survey of their electric wiring. Part I is a step-by-step guide for making an over-all survey of the wiring, lighting, motors, and other electrical equipment. Part II provides forms for a detailed report on the conditions found in each feeder, sub-feeder, and branch circuit of the whole wiring system. Wiring system layouts for plants and single buildings can be conveniently prepared from the data obtained in Parts I and II. The purpose of the survey is to determine the condition of the wiring system with respect to adequacy, defects, safety, deterioration or obsolescence. The check lists will prove a great convenience in making the survey complete in every detail. Copies are available on request to the company.

Oliver United Filters, Inc., announces the appointment of **E. D. Flynn** as chief engineer of the company, with headquarters at Oakland, Calif. He will direct engineering for both the Oakland, California, and Hazleton, Pennsylvania, factories.

Safety is the title of an illustrated booklet issued by the National Safety Council, 20 North Wacker Drive, Chicago. It contains letters from presidents of 23 large industrial organizations which contain unusual interpretations of the economic and human values of accident prevention.

Gold Savers, Ltd., of Vancouver, B. C., announce that the company has entered into a manufacturing and sales agreements with **Fraser & Chalmers,** of Erith, Kent, England, whereby that company will handle the Lorentsen centrifugal gold saving machine throughout the world excepting the United States.

BULLETINS

Chain Drives. Morris Chain Co., Ithaca, N. Y. Illustrated bulletin of chain drives and numerous tables giving data on chains, drives, and sprockets; also general information on chain-drive installation. Pp. 49.

Pipe Tools. Beaver Pipe Tools, 330-770 Dana Ave., Warren, Ohio. Catalog No. 37, illustrates and describes dies, portable pipe machines, large curlers, and threading and rachet pipe reamers. Pp. 40.

Vibrating Screens. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill. Catalog 1562. Illustrated booklet of screens for ores and non-metallics. Pp. 23.

Forged Flanges. Kropp Forge Co., Chicago, Ill. Bulletin No. 125. Dimension, weights, and prices on standard flanges from ¾ in. to 24 in. Pp. 23.

Electric Shovels. Harnischfeger Corp., Milwaukee, Wis. Bulletin X-9, illustrating and describing the P-H Ward Leonard electric shovels. Pp. 21.

Insulating Materials. Johns-Manville Corporation, 22 East 40th St., New York City. A well-illustrated catalog, with information on high- and low-temperature insulation for numerous industrial needs. Pp. 60.

Mill Drive. Patterson Foundry & Machine Co., East Liverpool, Ohio. Folder explains operation of a drive unit containing a magnetic brake and inching device.

Detachable Bit. Sullivan Machinery Co., 307 North Michigan Ave., Chicago, Ill. Bulletin 87 P mentions the features of the company's new detachable bit. Pp. 4.

Vibrating Screens. Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1479 on Style B centrifugal vibrating screens used for sizing all materials pertaining to the crushing and mining industries. Pp. 10.

Explosives. Atlas Powder Co., Wilmington, Del. Catalog lists numerous types of explosives, electric blasting caps, and all blasting accessories. Pp. 44.

Centrifugal Pumps. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin W-318-B5A on two-stage volute centrifugal pumps. Pp. 4.

Inclosed Fan-Cooled Motors. General Electric Co., Schenectady, N. Y. Bulletin GEA 1326 B explains parts of the company's totally inclosed fan-cooled induction motor. Pp. 4; totally inclosed hoist motors GEA-1366 A. Pp. 2; explosion-proof totally inclosed fan-cooled induction motor for hazardous locations, GEA-1341 C. Pp. 4; Type K totally inclosed induction motors, GEA-1538A. Pp. 2; Splash-proof induction motors GEA-1619 B. Pp. 4; general-purpose squirrel-cage induction motors GEA-2345 Pp. 7.

Jackhamers. Ingersoll-Rand Co., 11 Broadway, New York. Bulletin 2266 describing the new JA-45 Jackhamers. Pp. 4.

Drill Steel. Edgar Allen & Co., Ltd., Imperial Steel Works, Sheffield 9, England. Folder illustrating rock drills and drill steel and describing characteristics of mining steels. Pp. 7.

Diamond Drills. E. J. Longyear Co., Minneapolis, Minn. Bulletin 49, describing general features of the newest Straitline drill weighing only 750 lb. Pp. 4.

Exhaust Fans. Northern Blower Co., West 65th St., Cleveland, Ohio. Bulletin 1002-2, describing slow-speed exhaust fans used in connection with dust-collecting and fume-recovery equipment. Pp. 4.

Spray Nozzle. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill. Folder 1407 describes non-clogging spray nozzles. Pp. 4.

Centrifugal Pumps. Allis-Chalmers Mfg. Co., Milwaukee, Wis. Leaflet 2224 shows general construction and dimension tables and drives. Pp. 4.

Flotation Machine. Smith Engineering Works, Milwakee, Wis. Folder describing the Telsmith-Patek flotation machine and its principles of operation, agitation, circulation, and aeration. Pp. 4.

Portland Drills. Loomis Machine Co., Tiffin, Ohio. Booklet describing the new improved K-4 drill rig. Pp. 13.

Dust Control. American Foundry Equipment Co., Mishawaka, Ind. Book 22 illustrates, by photographs and blueprints, the features of the new American "Dustube" collector for industrial uses. Pp. 23.

SUMMARY OF

MONTHLY COMMENT . . . DAILY AND AVERAGE MONTHLY

THE UPWARD trend in prices that attracted wide attention in November was even more pronounced in the last month of 1936. The temporary shortage in spot metal at European ports, coupled with heavy speculative operations in London, sent the price of copper on the very last day of the year to a new high for the movement. As in November, the higher London market forced domestic sellers to revise their prices upward, particularly in copper and lead. London prices in these metals actually moved above domestic levels.

Domestic copper advanced to 12c. per pound, Valley basis, on Dec. 31, the highest figures since June 26, 1930. The price was raised to that level to conserve domestic supplies for the domestic market. Production here is increasing, but it takes time to translate production at the mines into the refined product. Sales in the domestic market during December totaled 117,715 tons, against 88,178 tons in November. World production of blister copper, mine and scrap, during November amounted to 169,218 tons, against the monthly low for 1936 of 122,319 tons in July. Apparent consumption of refined copper for the world during the last quarter of the year averaged about 165,000 tons a month. World stocks of refined copper at the end of November amounted to 353,258 tons, of which total not much more than 57 per cent consisted of "industry stocks." Standard copper, spot, on the London Metal Exchange advanced £5 3/16 per ton during December.

Domestic stocks of refined lead at the end of November amounted to 176,914 tons, against the high for the year of 231,081 tons at the end of July. Stocks of lead abroad are described as "tight" in metal circles. Late in the month spot lead in London was quoted at the equivalent of 6.30c. per pound. The New York quotation of 6c. is the highest since March 5, 1930.

Speculators in London left tin alone and the price showed little net change. Siam has ratified the new tin pact.

The *E. & M. J.* index number of non-ferrous metal prices for December was 80.50, against 77.19 in November.

United States Market

1936 Dec.	Electrolytic Copper—Domestic (a)	Electrolytic Copper—Export (b)	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
1	10.275	10.400	51.375	5.20	5.05	5.05
2	10.275	10.325	51.250	5.20	5.05	5.05
3	10.275	10.325	50.850	5.20	5.05	5.05
4	10.275	10.325	50.625	5.20	5.05	5.05
5	10.275	10.325	50.625	5.20	5.05	5.05
7	10.275	10.325	50.750	5.20	5.05	5.05
8	10.275	10.375	51.750	5.20	5.05	5.05
9	10.275	10.425	52.125	5.20	5.05	5.05
10	10.275	10.450	52.375	5.20	5.05	5.15
11	10.275	10.500	52.250	5.30	5.15	5.15
12	10.275	10.525	51.875	5.30	5.15	5.15
14	10.275@10.775	10.550	51.750	5.40@5.50	5.25@5.35	5.15@5.25
15	10.775	10.700	52.750	5.50	5.35	5.25@5.35
16	10.775	10.825	52.875	5.50	5.35	5.35
17	10.775	10.875	52.625	5.50	5.35	5.45
18	10.775	10.900	52.250	5.50	5.35	5.45
19	10.775	10.925	52.200	5.50@5.60	5.45	5.45
21	10.775	11.000	52.000	6.00	5.85	5.45
22	11.400	11.175	52.000	6.00	5.85	5.45
23	11.400	11.400	51.900	6.00	5.85	5.45
24	11.400	11.425	51.800	6.00	5.85	5.45
25	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday
26	11.400	11.425	51.800	6.00	5.85	5.45
28	11.400	11.525	52.250	6.00	5.85	5.45
29	11.400@11.525	11.550	52.200	6.00	5.85	5.45
30	11.400	11.525	51.500	6.00	5.85	5.45
31	11.775	11.600	51.650	6.00	5.85	5.45
Av. for month	10.763	10.835	51.823	5.554	5.406	5.273
Averages for Week						
Dec.						
2	10.275	10.417	51.945	5.20	5.05	5.05
9	10.275	10.350	51.121	5.20	5.05	5.05
16	10.483	10.592	52.313	5.375	5.225	5.217
23	10.983	11.046	52.163	5.758	5.617	5.450
30	11.413	11.490	51.910	6.000	5.850	5.450
Calendar Week Averages						
Dec.						
5	10.275	10.358	51.121	5.200	5.050	5.05
12	10.275	10.433	51.854	5.233	5.083	5.10
19	10.733	10.796	52.408	5.500	5.358	5.367
26	11.275	11.285	51.900	6.000	5.850	5.450

Silver, Gold, and Sterling Exchange New York and London

1936 Dec.	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	4.90875	4.90375	46.000	21.1250	141s 7 d	$35.00
2	4.90625	4.90125	46.500	21.3125	141s 8½d	35.00
3	4.90375	4.89875	46.000	21.2500	141s 9½d	35.00
4	4.90000	4.89500	45.750	21.1875	141s 9½d	35.00
5	4.89750	4.89125	(e)	21.3125	141s 11½d	35.00
7	4.89625	4.88875	45.750	21.3125	142s 1 d	35.00
8	4.90625	4.89875	45.250	21.2500	141s 9½d	35.00
9	4.90375	4.89625	45.000	21.0625	141s 9 d	35.00
10	4.90250	4.89500	45.250	21.1875	142s ½d	35.00
11	4.90000	4.89250	45.250	21.1875	141s 9½d	35.00
12	4.90250	4.89500	(e)	21.1875	141s 10d	35.00
14	4.90625	4.89750	45.500	21.3750	141s 9 d	35.00
15	4.90500	4.89625	45.250	21.3125	141s 9 d	35.00
16	4.91125	4.90250	45.000	21.2500	141s 7 d	35.00
17	4.91250	4.90500	45.250	21.3125	141s 5½d	35.00
18	4.91000	4.90250	45.250	21.2500	141s 6½d	35.00
19	4.91000	4.90250	(e)	21.3750	141s 7 d	35.00
21	4.90875	4.90000	45.250	21.3125	141s 8½d	35.00
22	4.91125	4.90250	45.000	21.2500	141s 7 d	35.00
23	4.91125	4.90375	44.875	20.8750	141s 6 d	35.00
24	4.91125	4.90250	45.000	21.0625	141s 6½d	35.00
25	Holiday	Holiday	Holiday	Holiday	Holiday	Holiday
26	Holiday	Holiday	Holiday	Holiday	Holiday	35.00
28	4.91375	4.90375	45.250	21.2500	141s 6½d	35.00
29	4.91125	4.90250	45.125	21.2500	141s 4 d	35.00
30	4.90750	4.90000	45.250	21.3750	141s 8 d	35.00
31	4.91000	4.90250	45.000	21.3125	141s 7 d	35.00
Av. for month	4.90670	.....	45.352	21.238	.....	35.00
Averages for Week						
Dec.						
2	4.90225	.....	45.688	.....	.....	.....
9	4.90125	.....	45.550	.....	.....	.....
16	4.90458	.....	45.250	.....	.....	.....
23	4.91063	.....	45.125	.....	.....	.....
30	4.91094	.....	45.156	.....	.....	.....

Calendar week averages: New York Silver, Dec. 5th, 45.875; 12th, 45.300; 19th, 45.250; 26th, 45.031.
(e) No quotation (Saturday).

The above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and interest charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.300c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less then 1c. over the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order issued April 24, 1935, the U. S. Government's price on newly mined domestic silver was established at 77.57. Handy & Harman's quotation for domestic silver, .999 fine, was 77c. per ounce throughout December.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

THE MARKETS

PRICES OF METALS . . . MISCELLANEOUS QUOTATIONS

London Market

1936	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Standard					
Dec.	Spot	3M	Bid	Spot	3M	Spot	3M	Spot	3M
1	43.3750	43.7500	48.5000	230.2500	229.7500	22.6875	22.6250	16.1875	16.5000
2	43.3125	43.6250	48.0000	231.2500	230.0000	22.7500	22.6875	16.2500	16.5625
3	43.4375	43.8125	47.7500	229.0000	228.7500	22.6250	22.6250	16.2500	16.5625
4	43.4375	43.8125	47.7500	226.0000	226.0000	22.6250	22.5625	16.1250	16.4375
7	43.7500	44.1250	48.0000	227.0000	227.0000	22.8750	22.8125	16.2500	16.5625
8	44.3750	44.6250	48.7500	228.5000	228.5000	23.3750	23.3125	16.2500	16.6250
9	44.3750	44.6875	48.7500	231.5000	231.5000	24.0625	23.9375	17.0000	17.0000
10	44.3750	44.6875	48.7500	232.2500	232.0000	24.1875	24.1875	17.0000	17.2500
11	44.6250	44.9375	49.0000	234.2500	234.2500	24.6250	24.6250	17.5000	17.8125
14	45.0625	45.4375	49.0000	230.5000	230.5000	25.7500	25.7500	17.7500	18.0625
15	45.9375	46.3125	50.2500	233.5000	233.5000	26.0625	26.0625	18.5625	18.8125
16	46.0000	46.2500	50.2500	236.7500	236.7500	25.8750	25.8750	18.5625	18.8125
17	45.8125	46.1250	50.2500	236.6250	236.6250	25.5625	25.5000	18.5000	18.5625
18	46.2500	46.5625	50.5000	234.5000	234.5000	25.9375	25.9375	18.2500	18.5625
21	47.0625	47.3750	51.2500	232.7500	232.7500	27.3750	27.2500	18.8750	19.0625
22	47.7500	48.0000	52.0000	233.0000	233.0000	27.1250	27.1250	18.9375	19.0625
23	48.1250	48.3750	52.7500	232.0000	232.2500	28.1250	27.8750	18.9375	18.9375
24	47.9375	48.2500	52.7500	231.7500	232.0000	27.5000	27.5000	19.0000	19.0000
25		Holiday		Holiday		Holiday		Holiday	
28	48.7500	49.0625	53.0000	233.5000	233.7500	28.1875	28.1875	19.0000	19.0000
29	49.1875	49.4375	53.7500	235.5000	236.0000	28.6875	28.6250	20.0000	20.0000
30	48.5000	48.7500	53.0000	233.0000	233.7500	27.9375	27.8125	19.9375	19.9375
31	49.3750	49.6875	54.0000	233.0000	233.5000	28.3750	28.1875	19.9375	20.0625
Av. for month	45.946	.....	50.364	232.108	.....	25.560	25.503	17.957	18.145

Current Prices—Miscellaneous Metals, Ores, and Non-Metallic Minerals

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(January 2, 1937)

Miscellaneous Metals

Aluminum, ingot, 99 plus per cent, lb.	19@21c.
Antimony, domestic, spot, lb.	13.750c.
Bismuth, ton lots, lb.	$1.00
Cadmium, lb.	75c@$1.05
Chromium, 97 per cent grade, lb.	85c.
Nickel, electrolytic cathodes, lb.	35c.
Magnesium, 99.8 per cent, carloads, lb.	30c.
Palladium, troy oz.	$24.00
Platinum, (official quotation) troy oz.	$48.00
Quicksilver, flask of 76 lb., 100 flasks or more	$88.50@$92.00
Radium, mg. radium content	$40.00
Selenium, 99.5 per cent, lb.	$2.00
Silicon, minimum 97 per cent, spot, lb.	16.50c.
Tellurium, lb.	$1.75@$2.00
Thallium, 100 lb. or more, lb.	$6.50
Titanium, 96 to 98 per cent, lb.	$6.00
Zirconium, commercially pure, lb.	$7.00

Metallic Ores

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 45@47 per cent, c.i.f. Atl. ports, long ton	$17.00@$18.00
Iron Ore, Lake Superior, lower Lake ports, long ton:	
Old Range bessemer	$4.80
Mesabi bessemer	$4.65
Old Range non-bessemer	$4.65
Mesabi, non-bessemer	$4.50
Lead (Galena) 80 per cent Joplin, Mo., ton	$69.50@$70.93
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52@55 per cent	30c.
49@51 per cent	29c.
44@47 per cent	25c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	42c.
Tungsten Ore, per unit of WO_3:	
Chinese duty paid	$15.50
Domestic Scheelite	$16.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton.	$35.00

Metallic Compounds

Arsenious Oxide (arsenic) lb.	3½c.
Cobalt Oxide, 70@71 per cent, lb.	$1.41@$1.51
Copper Sulphate, 100 lb.	$4.45
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb.	$1.34
Sodium Sulphate, bulk, ton	$13.00@$15.00

Alloys

Beryllium-Copper, Master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$23.00@$30.00
Ferrochrome, 65@70 per cent chromium, 4@6 per cent carbon, lb.	10c.
Ferromanganese, 78@82 per cent, gross ton	$80.00
Ferromolybdenum, 50@60 per cent Mo, lb. of Mo contained	95c
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75@80 per cent, lb. of W contained	$1.30@$1.40

Non-Metallic Minerals

Asbestos, f.o.b. mines ton:	
Canadian (Quebec)	
Crude No. 1	$550@.....
Crude No. 2	$200@$225
Spinning fibers	$90@$150
Paper stock	$32.50@$37.50
Shorts	$11@$14.50
Vermont	
Shingle stock	$47.50.....
Paper stock	$35@.....
Cement stock	$23@.....
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 95 per cent $BaSO_4$, less than 1 per cent iron	$5.50
Bauxite, long ton:	
Domestic, chemical, 55@58 per cent	$6@ $7.50
Domestic, abrasive, 78@84 per cent	$12.50@$15.00
Dalmatian, 50@55 per cent	(a)$5.50@ $7.00
French, 56@59 per cent	(a)$6.50@ 7.50
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, bulk	$6.50@ $9.00
Delaware, No. 1	$14.00@.....
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85-5 per cent, all rail movement, ton	$18.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00@.....
Dead-burned, f.o.b. Washington	$24.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	15@30c.
2 x 2 in.	30@50c.
3 x 3 in.	75@$1.00
3 x 4 in.	$1.00@$1.25
4 x 6 in.	$2.00@$2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.50
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a)12@12½c.
Silica, water-floated, in bags, 325 mesh, ton	$16.00@$40.00
Sulphur, Texas mines, long ton	$18.00@.....
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$8.50@ $9.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$15.00@.....
200 mesh, cream colored	$25.00@.....

(a) Nominal.

Iron and Steel

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$21.00
Basic	$20.00
No. 2 Foundry	$20.50
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb.	$1.90
Bars, 100 lb.	$2.05

MONTHLY AND YEARLY AVERAGE PRICES

Silver and Sterling Exchange

	New York		London Spot		Sterling Exchange	
	1935	1936	1935	1936	1935	1936
January	54.418	47.250	24.584	20.250	489.207	496.115
February	54.602	44.750	24.818	19.796	487.278	499.908
March	59.048	44.750	27.380	19.663	477.635	496.952
April	67.788	44.892	30.986	20.245	483.596	494.139
May	74.356	44.869	33.865	20.248	488.587	496.850
June	71.940	44.750	32.346	19.770	493.245	501.817
July	68.216	44.750	30.500	19.590	495.558	502.178
August	66.366	44.750	29.476	19.490	496.815	502.519
September	65.375	44.750	29.255	19.579	492.917	503.455
October	65.375	44.750	29.368	19.977	490.577	489.755
November	65.375	45.431	29.284	21.050	492.277	488.727
December	58.420	45.352	25.563	21.238	492.715	490.670
Year	64.273	45.087	28.952	20.075	490.034	496.924

New York quotations for silver not eligible for sale to U. S. Government, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		(a) Electrolytic	
	1935	1936	1935	1936	1935	1936	1935	1936
January	8.775	9.025	6.583	8.358	28.077	34.706	31.261	38.788
February	8.775	9.025	6.341	8.566	27.175	35.313	30.244	39.463
March	8.775	9.025	6.526	8.708	28.518	36.040	31.607	40.227
April	8.775	9.169	7.328	8.849	31.231	36.975	34.763	41.131
May	8.775	9.275	7.794	8.819	33.344	36.690	36.733	40.839
June	8.634	9.275	7.307	8.790	30.799	36.324	34.039	40.357
July	7.775	9.352	7.350	8.993	31.024	37.217	34.261	41.228
August	7.979	9.525	7.738	9.297	32.646	38.259	35.976	42.375
September	8.504	9.525	8.146	9.523	34.036	38.915	37.952	43.267
October	8.967	9.563	8.514	9.669	35.226	40.980	39.609	45.295
November	9.025	10.161	8.414	10.349	35.229	43.932	39.396	48.467
December	9.025	10.763	8.414	10.835	35.097	45.946	39.313	50.364
Year	8.649	9.474	7.538	9.230	31.867	38.441	35.430	42.650

New York quotations, cents per pound. London, pounds sterling per long ton (a) Bid quotation.

Lead

	New York		St. Louis		London			
	1935	1936	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos
January	3.692	4.500	3.542	4.350	10.321	10.514	15.397	15.494
February	3.528	4.515	3.378	4.365	10.216	10.413	16.022	16.141
March	3.579	4.600	3.429	4.450	11.012	11.188	16.608	16.767
April	3.692	4.600	3.542	4.450	12.231	12.459	16.097	16.234
May	3.962	4.600	3.812	4.450	13.861	13.940	15.530	15.601
June	4.020	4.600	3.870	4.450	13.776	13.806	15.170	15.259
July	4.123	4.600	3.973	4.450	14.451	14.511	15.856	15.954
August	4.254	4.600	4.104	4.450	15.774	15.792	16.772	16.859
September	4.413	4.600	4.263	4.450	16.262	16.315	18.009	17.974
October	4.512	4.631	4.362	4.488	18.209	18.209	18.446	18.375
November	4.500	5.114	4.350	4.964	17.938	17.935	21.723	21.693
December	4.500	5.554	4.350	5.406	16.803	16.828	25.560	25.503
Year	4.065	4.710	3.915	4.560	14.238	14.326	17.599	17.655

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

Tin

	Straits New York		Standard, Spot London	
	1935	1936	1935	1936
January	50.916	47.234	231.193	209.731
February	50.063	47.962	227.381	207.081
March	46.962	48.037	215.726	213.080
April	50.154	46.963	223.513	209.313
May	51.138	46.352	227.602	202.429
June	51.108	42.204	227.586	183.167
July	52.297	43.021	232.397	185.957
August	50.463	42.579	222.935	183.731
September	49.126	44.754	223.929	194.676
October	51.160	44.975	226.891	201.193
November	51.864	51.392	226.452	230.869
December	49.794	51.823	220.075	232.108
Year	50.420	46.441	225.473	204.445

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos
January	3.730	4.848	11.994	12.207	14.488	14.719
February	3.714	4.859	11.819	12.000	15.125	15.391
March	3.894	4.900	12.095	12.250	15.983	16.190
April	4.030	4.900	12.891	13.128	15.181	15.334
May	4.220	4.900	14.534	14.685	14.536	14.777
June	4.299	4.880	13.734	13.898	13.896	14.122
July	4.325	4.783	14.065	14.185	13.579	13.826
August	4.535	4.800	14.714	14.938	13.528	13.759
September	4.669	4.850	15.414	15.616	13.906	14.159
October	4.825	4.850	16.440	16.674	14.554	14.835
November	4.850	4.974	16.193	16.372	16.301	16.554
December	4.850	5 273	15.091	15.278	17.957	18.145
Year	4.328	4.901	14.082	14.269	14.920	15.151

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1935	1936	1935	1936
January	55.000	105.000	20.000	20.000
February	55.000	105.000	20.000	20.000
March	58.462	105.000	20.000	20.000
April	65.000	105.000	20.000	20.000
May	65.000	105.000	20.000	20.000
June	65.000	105.000	20.000	20.000
July	65.000	93.462	20.000	20.000
August	70.000	90.000	20.000	20.000
September	75.625	90.000	20.000	20.000
October	85.000	90.000	20.000	20.000
November	85.000	90.000	20.000	20.000
December	101.800	90 000	20.000	20.000
Year	70.491	97.789	20.000	20.000

Aluminum in cents per pound, 99 per cent grade. Cadmium, cents per pound.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1935	1936	1935	1936	1935	1936
January	14.111	12.736	72.760	76.769	34.000	36.885
February	14.250	12.967	72.500	77.000	34.000	35.000
March	14.250	13.072	72.500	77.000	32.846	34.115
April	14.029	12.673	72.500	76.731	32.000	32.846
May	12.712	12.410	72.135	74.940	32.000	32.000
June	12.500	11.707	71.460	74.192	32.000	36.346
July	12.500	11.245	70.538	73.423	32.000	39.308
August	12.500	11.125	69.000	73.923	31.333	49.577
September	13.177	11.740	69.208	85.280	36.000	68.960
October	15.322	12.058	71.750	89.240	37.615	54.074
November	14.217	12.233	74.348	90.250	38.000	48.000
December	13.820	12.918	75.200	90.250	38.000	48.000
Year	13.616	12.240	71.992	79.917	34.150	42.926

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1935	1936	1935	1936	1935	1936
January	19.00	20.00	18.00	19.00	18.50	19.50
February	19.00	20.00	18.00	19.00	18.50	19.50
March	19.00	20.00	18.00	19.00	18.50	19.50
April	19.00	20.00	18.00	19.00	18.50	19.50
May	19.00	20.00	18.00	19.00	18.50	19.50
June	19.00	20.00	18.00	19.00	18.50	19.50
July	19.00	20.00	18.00	19.00	18.50	19.50
August	19.00	20.00	18.00	19.00	18.50	19.50
September	19.00	20.00	18.00	19.00	18.50	19.50
October	19.00	20.00	18.00	19.00	18.50	19.50
November	20.00	20.23	19.00	19.23	19.50	19.73
December	20.00	21.00	19.00	20 00	19.50	20.50
Year	19.167	20.103	18.167	19.103	18.667	19.603

Iron in dollars per long ton. F.o.b. Mahoning and Shenango Valley furnaces.